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SOME PARASITES OF AUSTRALIAN VERTEBRATES.

*BY PATRICIA M. MAWSON**

Summary

Four nematodes from marsupials are described as new species, *Labiostrongylus kungi* from *Macropus* major, *Spirostrongylus kartana* from *Thylogale eugenii*, *Phascolostrongylus stirtoni* and *Macropostrongylus lasiorhini* from *Lasiorhinus latifrons*; other species recorded are *Pharyngostrongylus alpha* Johnston and Mawson (*Macropus major*), *Diplotriaena alpha* Johnston and Mawson (*Calamanthus fuliginosus*), *Streptocara recta* (Linst.) (*Podiceps novaehollandiae*) and *Physaloptera bancrofti* Irwin Smith and *Ophidascaris filaria* (Duj.) (*Aspidites melanocephalus*). *Pharyngostrongylus parma* Johnston and Mawson and *P. gallardi* Johnston and Mawson are both referred to genus *Spirostrongylus* Yorke and Maplestone, and a key to species of this genus is given.

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[Read 8 April 1954]

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LIST OF PARASITES

List of parasites examined, arranged under their hosts.

Aspidites melanocephalus (Krefft), *Ophidascaris filaria* (Duj.), *Physaloptera bancrofti* Irwin-Smith (Queensland).

Calamanthus fuliginosus Vig. and Horst. *Diplotriaena alpha* J. and M. (South Australia).

Podiceps ruficollis Vroeg. *Streptocara recta* (Linst.) (South Australia).

Macropus major Shaw, *Labiostrongylus kungi* n. sp., *Pharyngostrongylus alpha* J. and M., (New South Wales).

Lasiorhinus latifrons (Owen), *Phascolostrongylus stirtoni* n. sp., *Macropostrongylus lasiorhini* n. sp., (South Australia).

Thylogale eugenii Per. and Less. *Spirostrongylus kartana* n. sp., (Kangaroo Island).

ACKNOWLEDGMENTS

The nematodes reported on in this paper were sent for examination by various people. Professor Stirton, a visitor to South Australia from Berkeley University, California, U.S.A., collected and dissected the wombats from which two new species of Strongyle worms were taken; Dr. Flecker of the Queensland Naturalists' Club sent the stomach of *Aspidites melanocephalus*. The material from *Macropus major* was sent for identification by the Director of the New South Wales Department of Agriculture Veterinary Research Station at Glenfield, New South Wales; the worms from the wren *Calamanthus fuliginosus* were collected by S. J. Edmonds of this Department. I am indebted to these collectors for opportunities they have provided for the examination of interesting material.

PHARYNGOSTRONGYLUS ALPHA Johnston and Mawson

Fig. 1 - 2

Several specimens of this species were present in material from the kangaroo (*Macropus major*) from New South Wales. *Pharyngostrongylus alpha* is apparently very common in the red and grey kangaroo. The present material comprises rather larger worms than have hitherto been recorded, and the length of the spicule and of the female tail is greater.

The males are up to 10·2 mm., the females to 11·2 mm. in length; the spicules are 1·7 mm. long, 1/5·7 of the body length; the female tail is 0·48 mm. long, and the vulva 0·15 mm. in front of this. Eggs in the vagina are 0·14 mm. by 0·08 mm. Earlier descriptions state that the labial papillae are without setae; however, in some specimens a pair of very small setae are present on the submedian papillae.

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The genus SPIROSTRONGYLUS Yorke and Maplestone 1926

The genus *Spirostrongylus* was erected by Yorke and Maplestone 1926 (p. 68) for a species of worm found in a wallaby. The exact location of the worm in the animal was not indicated by them; the worms however were distinctive among Trichoneminae from marsupials in being "spirally rolled." Since then two other species with a similar habit, and closely resembling *Spirostrongylus* in other features, have been described from the oesophagus of wallabies; these were both referred, probably erroneously, to the genus *Pharyngostrongylus*, as *P. parma* Johnston and Mawson 1939, and *P. gallardi* Johnston and Mawson 1942. A species with similar habitat and habit, is described below.

The earlier species were kept distinct from the genus *Spirostrongylus* mainly because of the absence of a leaf crown. *En face* examination of the species described below shows that there are numerous very small chitinous projections from the anterior end of the buccal cavity, and these may well be present in the other species; they are so small that they would not be seen in other than *en face* view. Apart from the small size or possible absence of the leaf crown, the four species are very similar. It is now suggested that the following species belong to the genus *S. spirostrongylus* Yorke and Maplestone, *S. parma* Johnston and Mawson, *S. gallardi* Johnston and Mawson, and *S. kartana* n. sp. A key to the species has been prepared.

1.	Vestibule longer than 40μ	2
	Vestibule shorter than 35μ long	3
2.	Vestibule 70μ long; female tail 50μ long	*S. kartana* n. sp.
	Vestibule 45μ long; female tail 230μ long	*S. gallardi* J. & M.
3.	Vestibule 15μ long; with very thick walls	*S. parma* J. & M.
	Vestibule 25-27μ long, walls not thick	*S. spirostrongylus* Y. & M.

Spirostrongylus kartana n. sp.

Fig. 3 - 6

Numerous small coiled worms were taken from the oesophagus of *Thylogale eugenii* from Flinders Chase, Kangaroo Island. The males were up to 8 mm. and the females to 9 mm. in length, and both sexes were tightly coiled into a spiral, both in life and death.

The cuticle is distinctly annulated. The setiform cervical papillae lie about 80μ behind the anterior end. The anterior end bears a cuticular roll on which are four rounded submedian papillae and two small lateral papillae. The buccal cavity is short, and leads to a vestibule (which may be homologous with buccal capsule) with strongly annulated walls, which are thickest near the mouth, and narrow gradually towards the base. The cavity of this vestibule is of even diameter, and is 9μ wide by 60μ long. The oesophagus is 0·65-0·75 mm. long, with the anterior two-thirds widening gradually, ending in a sudden constriction followed by a large bulb. The nerve ring lies at the level of the constriction, and the excretory pore is at this level or just behind it. The female tail is 50μ long, very short and pointed. Immediately in front of it is the vulva, 110μ in front of the posterior end of the body. The eggs are 140 x 70μ.

The spicules are 0·85 - 0·95 mm. long, alate, with simple tips. A heart-shaped gubernaculum is present. The bursa is not deeply lobed and bears no internal papillae. Only the dorsal ray reaches the edge of the bursa. The ventral rays lie together; the ventro-lateral ray is divergent form the medio- and postero-lateral, and the externodorsal which rises from the same root as the laterals is divergent from them. The dorsal ray is cleft nearly to its base, and each of the widely divergent branches reaches the bursal edge, giving off a short lateral branch at about two-thirds of its length.

The species is very like *S. gallardi* Johnston and Mawson, differing chiefly in the length of the vestibule and of the female tail.

Labiostrongylus kungi n. sp.

Fig. 7-9

A new species of the genus *Labiostrongylus* was taken from *Macropus major* in New South Wales. The species is very close to *L. longispicularis* Wood, which apparently is common in kangaroos from all parts of Australia, but differs in the form of the dorsal ray of the bursa and in the spicule length. The name *L. kungi* has been given in recognition of the work done on the genus by Kung.

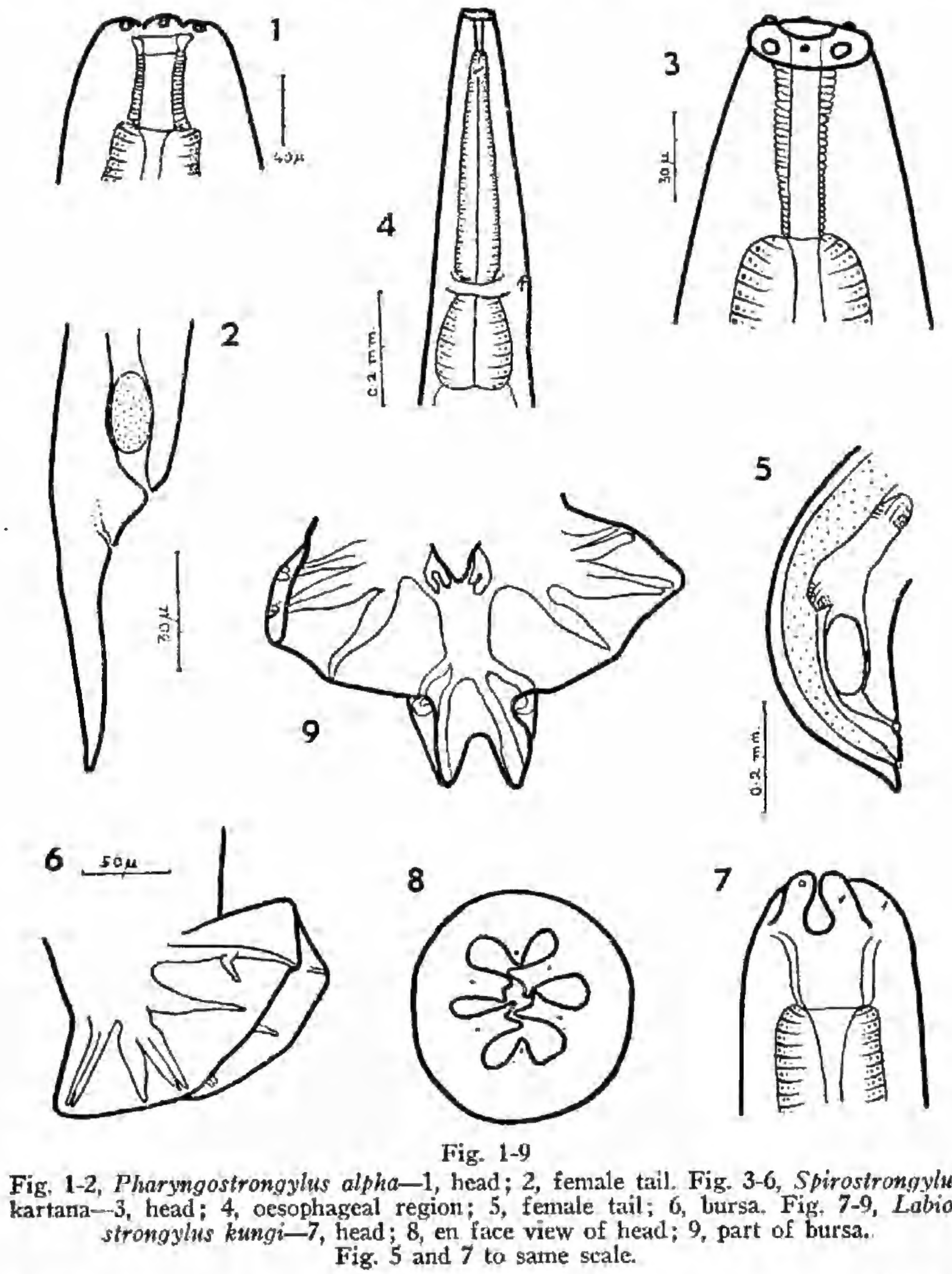

Fig. 1-9

Fig. 1-2, *Pharyngostrongylus alpha*—1, head; 2, female tail. Fig. 3-6, *Spirostrongylus* kartana—3, head; 4, oesophageal region; 5, female tail; 6, bursa. Fig. 7-9, *Labiostrongylus kungi*—7, head; 8, en face view of head; 9, part of bursa. Fig. 5 and 7 to same scale.

The males are up to 48 mm. in length, the females to 60 mm. The cuticle is firmly annulated; a pair of small threadlike cervical "papillae" lie 0·7 - 0·8 mm. from the anterior end. There are six lips, the two lateral shorter than the submedian; the lateral labial papillae are rounded and lie near the apex of the lips;

the submedian papillae are setiform and lie at about mid-length on the lips. The buccal capsule is deep, 0·15 mm. long by 0·11 mm. internal diameter, 0·15 mm. external diameter. The oesophagus is long, about quarter of the body length in the male; it is almost cylindrical, and the base is surrounded by a fold of "glandular" tissue. The nerve ring was not clearly discerned but is thought to lie at one-third of the oesophageal length from the head. The excretory pore was not seen. The female tail is 1·6 mm. long; the vulva is 3·2 mm. from the tip of the tail. Ripe eggs were not seen. The bursa of the male is very like that of *L. australis* Kung, differing only very slightly in the form of the dorsal ray (fig. 9). The genital cone is distinct, and bears two bifid accessory processes. The spicules are 5·2-6·0 mm. long, one-sixth to one-ninth of the body length.

Macropostrongylus lasiorhini n. sp.

Fig. 10 - 15

An apparently new species of the genus *Macropostrongylus* was taken from *Lasiorhinus latifrons* from near Blanchetown, South Australia. Both males and females were present, the males up to 1·5 mm. in length, the females to 2·0 mm. The cuticle is distinctly annulated. The lips are not distinct but there is a definite labial roll of tissue bearing the cephalic papillae, at the anterior end. Shortly behind this the body is constricted at the level of the hinder part of the buccal capsule, and from there widens rapidly to the base of the oesophagus, then more gradually to the middle region of the body, followed by a gradual narrowing to the tail. In the female the body narrows abruptly shortly in front of the anus, and ends in a short pointed tail.

There are six cushion-like cephalic papillae, each with a very short anteriorly directed seta. The buccal capsule narrows posteriorly, the anterior diameter being 32μ including the walls, the posterior 25μ; the depth of the base from the mouth is 50 to 55μ. The walls are thicker posteriorly. There are four strong tooth-like elements arising from the inner walls of the buccal capsule, two arising from the anterior end, two from about the mid-length. In en face view they are seen to be in submedian positions, the two subdorsal directed slightly towards one another, the two subventral similarly arranged. These are considered to be the elements of the internal leaf crown which is characteristic of the genus but which in this species are fewer in number and more heavily chitinized than usual.

The oesophagus is 1-1·1 mm. long in the male, 1·1-1·2 mm. in the female; the anterior third is cylindrical, surrounded near its base by the nerve ring; posterior to this the oesophagus widens greatly, to nearly five times its diameter at the nerve ring. The excretory pore lies just behind the nerve ring.

In the female the conical tail is short and pointed, 0·1 mm. long. The vulva is 0·12 mm. in front of the anus. The eggs are about 150 by 60μ.

The alate spicules are 1·0 mm. long. A pair of curved gubernacular plates, 0·2 mm. long, are present. The bursa has distinct dorsal and lateral lobes, and the two ventral lobes are not separated. The ventral rays are cleft near their tips and reach nearly to the edge of the bursa. The dorso- and medio-lateral rays lie together for their entire length, the anterolateral is separate from them and not quite so long; the externodorsal arises from the dorsal and is short. The dorsal bifurcates at about mid-length each branch bifurcating at half its length forming two terminal branches, of which the outer may be equal to or slightly longer than the inner and neither of which reach the outer edge.

The species is very close to *M. baylisi* Wood. The main differences lie in the proportions of the buccal capsule which is relatively deeper in the species from the wombat, and in the shape of the head and of the cephalic papillae. The female is longer. The spicule is longer in the species from the wombat; Wood describes four large and "a number" of smaller elements of the leaf crown. In the present species only the four larger elements are present, and of these only two arise from the mid-length of the walls of the buccal capsule.

Phascolostrongylus stirtoni n. sp.

Fig. 16-18

Only two female worms, an apparently new species belonging to the genus *Phascolostrongylus,* were collected from *Lasiorhinus latifrons,* and of these one only is entire. This reaches a length of 16 mm. They closely resemble *P. turleyi* Canavan but differ in certain features. The trivial name of the new species is given in recognition of the collector, Professor Stirton.

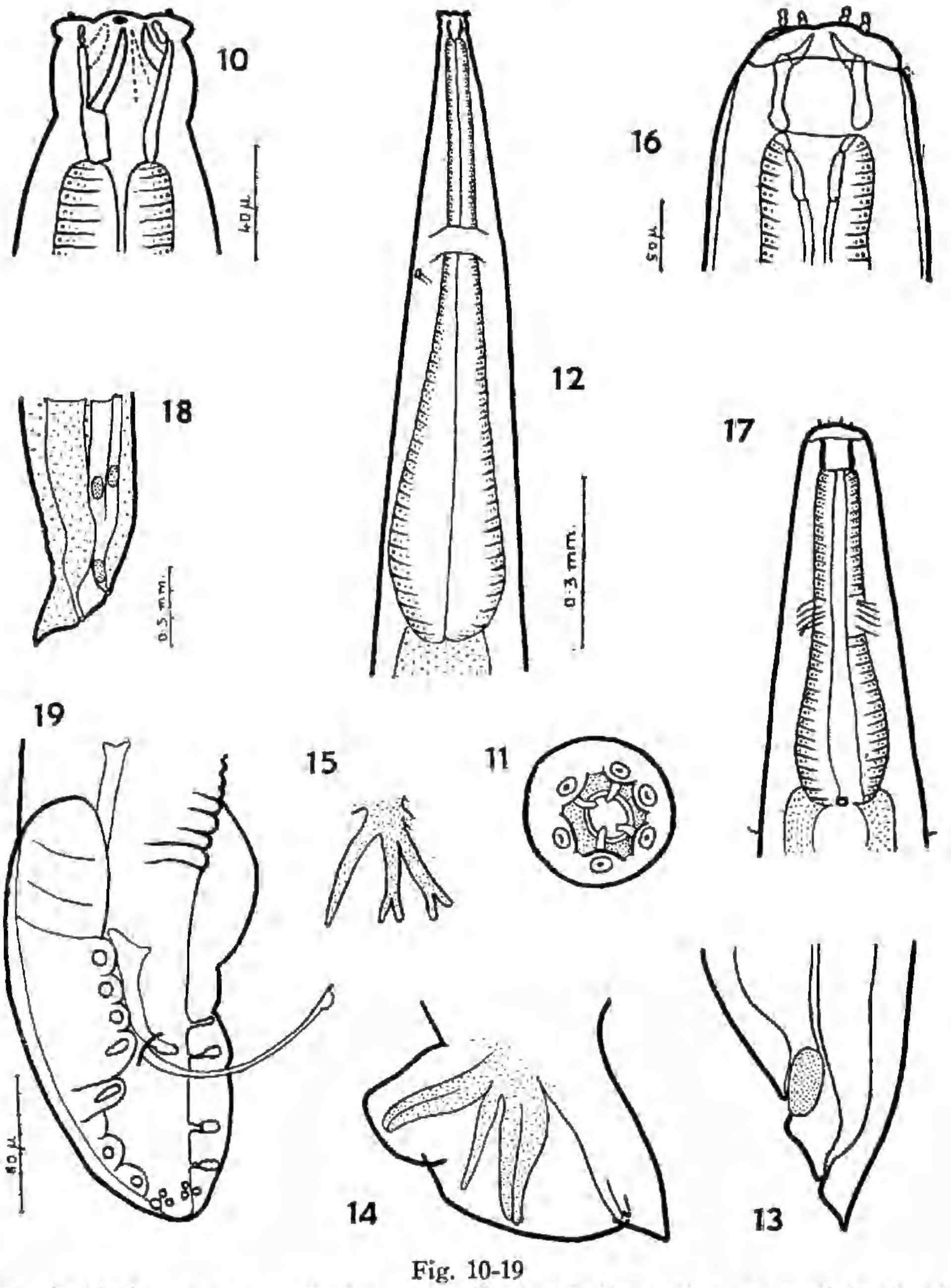

Fig. 10-19

Fig. 10-15, *Macropostrongylus lasiorhini*—10, head; 11, en face view of head; 12, oesophageal region; 13, female tail; 14, lateral view of bursa; 15, dorsal and externo-dorsal rays. Fig. 16-18—*Phascolostrongylus stirtoni*—16, head; 17, oesophageal region; 18, female tail; Fig. 19, *Streptocora recta*—male tail.
Fig. 10 and 11 to same scale. Fig. 12, 13, 14, 15 and 17 to same scale.

The cuticle is distinctly annulated throughout the body. There is a pair of elongate lateral "cervical" papillae lying a short distance posterior to the oesophagus. The cephalic papillae are six in number, the four submedian segmented, but each composed of two segments instead of three as described by Canavan. Canavan's figure is of two-partite papillae; possibly he considered the pulp, or nerve tissue, which passes forwards into the papilla, as a third segment. The part projecting beyond the lips is $10\,\mu$ in length ($24\,\mu$ in *P. turleyi*).

The buccal capsule is cylindrical rather than barrel-shaped. The eight leaf crown elements arise from the top of the buccal capsule. The oesophagus is 0·6 mm. long, slightly constricted where it is surrounded by the nerve ring, at 0·32 mm. from the mouth, and behind this widening slightly. The excretory pore is at the level of the posterior end of the oesophagus, not at mid-oesophagus as described for *P. turleyi*.

The body narrows abruptly a short distance in front of the vulva, and the tail is short and conical. The anus is 0·15 mm., and the vulva 0·3 mm. from the tip of the tail. The posterior lips of both the anus and the vulva are enlarged. An egg in the vagina is $84\,\mu \times 39\,\mu$.

Physaloptera bancrofti Irwin-Smith

Several worms, both males and females, from *Aspidites melanocephalus* from Cairns, Queensland, proved to be *Physaloptera bancrofti*. This species, originally described in 1922 from a lizard, *Gymnodactylus platurus* Shaw, from Narrabeen, Sydney, has not been recorded since then. The specimens from the snake are almost identical in size and proportions of parts of the body, arrangement of teeth on lips, and arrangement of bursal papillae, with the descriptions and figures given by Miss Irwin-Smith.

Streptocara recta (Linst.)

Fig. 19

Several specimens of *Streptocara recta* were taken from *Podiceps ruficollis*, from Meadows, South Australia. Both males and females are present, the males to 4·2 mm. long, the females to 5·5 mm.

The measurements generally agree with those described by Yamaguti 1935. The main difference is in the position of the vulva which in the present specimens lies nearer to the middle of the body, dividing it in ratio 5:4. The vestibule in the male is $23\,\mu$ long, $13\,\mu$ in diameter dorsoventrally and $6\,\mu$ laterally The cervical papillae in most specimens are quincuspid; in the males the central cusp is shorter than the others, in most female specimens all cusps are of equal length except in two cases; in one specimen the second and fourth cusps of both cervical papillae are elongate and bifid, and in another the central cusp of one cervical papillae only is similarly developed.

In the male the proximal ends of both spicules are greatly enlarged and the distal end of both are "barbed," that of the longer spicule being somewhat complex and twisted giving perhaps the corkscrew appearance commented on by Mueller. The post-anal papillae are not arranged in two separate groups as figured by Mueller. A figure of the male tail is given. The anterior end has been figured by Johnston and Mawson in an earlier publication (Johnston and Mawson 1941, 258).

Ophidascaris filaria (Dujardin)

This common parasite of snakes is now recorded from *Aspidites melanocephalus* from Cairns, Queensland.

Diplotriaena alpha Johnston and Mawson

A male and a female worm were taken from a field wren *Calamanthus fuliginosus*, by Mr. S. J. Edmonds near Keith, South Australia.

The male is 53 mm. long, 0·45 mm. maximum breadth, the female 75 mm. long, 0·6 mm. maximum breadth. The head bears four large papillae in submedian positions and a pair of very small lateral papillae (? amphids). The tridents are 0·1 mm. long in the male, 0·11 mm. in the female. The anterior part of the oesophagus is 0·35 mm. long in the male, 0·5 mm. in the female, and the total length of the oesophagus is 2·4 and 3·1 mm. in the female respectively. The nerve ring surrounds the anterior oesophagus at about its mid-length or a little behind this. The vulva lies shortly behind the end of the anterior oesophagus, 0·6 mm. from the head. The eggs are 26 - 31 μ by 45 μ.

The male tail is so clear that the spicules and papillae are hardly discernible. The longer spicule is 0·9 mm.

D. alpha was described from two female specimens. The only significant difference from these shown by the female from the wren is in the much shorter length of the posterior part of the oesophagus.

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THE STRATIGRAPHIC SUCCESSION IN THE VICINITY OF MT. BABBAGE STATION, SOUTH AUSTRALIA

BY G. D. WOODARD

Summary

Boulder-bearing grits in the vicinity of Muloowurtina Station, previously regarded as glacial deposits of Cretaceous (Winton) age, are lacustrine deposits in which many of the boulders are erratics derived from the Sturt Tillite. The presence of an upper Gondwana flora in these sediments and their conformable relationships with the overlying Aptian marine shales places them within the lower Cretaceous System. Correlation of these sediments has been made with the Blythesdale Sandstones (late Neocomian - early Aptian). The generally coarse clastic nature of the sediments, pronounced current bedding, and ripple marking of the lower grits give evidence in support of torrential stream accumulation into a lacustrine environment.

The Mt. Babbage and adjacent sections, previously described as early Tertiary (Eyrian) have been, on floral and lithological evidence, grouped as lower Cretaceous (Neocomian). These dominantly arenaceous sediments are overlain by fossiliferous marine clays of lower Cretaceous (Aptian) age, capped by a resistant siliceous Duricrust. Over the whole area a later deposit of piedmont gravels has been developed obscuring much of the outcrop of earlier sediments. Tentative regional correlation of the Mesozoic deposits of Mt. Babbage has been made with strata of a similar nature at Billy Springs, Copley and west of the Flinders Range.

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I. INTRODUCTION

Previous field investigations within this area have largely been confined to the metamorphic Precambrian Complex. W. G. Woolnough (1924) prepared a preliminary note on the occurrence of glacial erratics in the Muloowurtina area, but did not refer to the Mesozoic aspect of the associated flora or the marine nature of the overlying Lower Cretaceous sediments. A further paper prepared in association with Sir T. W. E. David (1926) discussed in further detail the occurrence of glacial erratics and the stratigraphic succession of this area.

Sprigg (1951) referred to the Mount Babbage section but was unable to visit the localities. Bowes (1952) similarly referred to the sediments of this locality as belonging to the Eyrian series.

The Mesozoic age of the Mt. Babbage sediments was first recognized by O. A. Jones, who determined the presence of *Otozamites* and other associated flora in specimens collected by S. B. Dickinson during the detailed mapping of the area.

FIELD WORK

Field studies of the Muloowurtina area were made by the writer during September 1953. The work included field reconnaissance, measuring and describing stratigraphic sections and the collection of representative fossils and samples of the section units.

II. GEOLOGY AND PHYSIOGRAPHY

The area under consideration is located within the vicinity of Muloowurtina Homestead, situated in latitude 29° 58′ south, longitude 139° 44′ east, 150 miles east of Copley, South Australia. The most marked physiographic feature of the area is the Flinders Ranges which consist of metamorphosed Precambrian sediments which have been faulted and subsequently dissected to form a high mountain range between 2,000 and 3,000 feet in height. In the vicinity of Muloowurtina the range has a marked linear escarpment trending roughly north-east and south-west.

Bordering the eastern slope of the range, a series of foothills of steeply dipping lower Cretaceous (Aptian) sediments consisting of fossiliferous blue-grey, yellow, and white gypsiferous clays and silty sands with a grey Duricrust capping, rises to a height of approximately 350 feet above the level of the eastern plains. High residuals of these Cretaceous beds form extensive tableland formations over much of the area north of the homestead, the beds, which are here fossiliferous, dipping gently to the east at approximately 3°. Adjacent to and overlying unconformably the Precambrian rocks is a series of cross-bedded and laminated intercalated grits, sands and carbonaceous clays which dip at 2°, N. 70° E., below the marine Cretaceous beds. Within these grits are occasional faceted boulders which have been regarded previously (David and Woolnough, 1926) as glacial in origin. These boulder beds, together with the underlying clastic and carbonaceous sediments, have been examined principally from a series of shallow cliff exposures:

1. Approximately two miles north-west of Muloowurtina homestead.
2. In the cliffs of Hamilton Creek from Terrapinna waterhole to south of the woolshed, $\frac{1}{4}$ mile west of the homestead.
3. From the fossil wood locality described in detail by Woolnough and David, $2\frac{1}{2}$ miles south of Muloowurtina.

The boulders whose origin has previously been regarded as glacial consist of a heterogeneous assortment of medium and coarse-grained quartz felspar porphyries, quartzite, quartz, slate, schists, etc., up to five feet in length, which are scattered, along with smaller rounded pebbles, in abundance over these areas. Some of the boulders exhibit well-defined planes of faceting, others are well rounded or irregular in shape. No glacial striae have been observed on the surface of the boulders though effects of fluviatile wear are generally well marked. The boulders in all three regions which were examined, either overlie, or are set in a coarse gritty heterogeneous sandstone of which the grains are sub-angular and dominantly quartzite in composition. In the most southerly examined locality, $2\frac{1}{2}$ miles from Muloowurtina, the dark brownish-yellow sandstone in which the boulders occur dips gently to the east at an angle of 11°, strike 330°. Gentle folding giving dips of approximately 3° has occurred in the vicinity of the woolshed. North of Terrapinna waterhole, micaceous sandstones, quartzites and ferruginous grits have been examined where they form high tablelands in the vicinity of Mount Babbage. These sediments, formerly regarded as Lower Tertiary (Eyrian) in age (Woolnough and David, 1926; Sprigg, 1951; Bowes, 1952), contain plant fossils and some lamellibranches. They are exposed at Mt. Babbage and in an extensive easterly dipping tableland nearby, as a thin capping (25-30 feet) unconformably resting on granitized Precambrian sediments (Bowes, 1952; Sprigg, 1951). West of Mt. Babbage a thick series of coarse cross-bedded grits, and gravels passing upwards into micaceous sands and massive fossiliferous quartzite is exposed in a deep valley unconformably above the Precambrian granite complex. Of these sediments the upper 30 feet of micaceous sands and quartzite is equivalent to the plateau formation of Mt. Babbage. The strata which have a marked easterly dip of 5° have a maximum measured thickness of 100 feet. Severe faulting in a north-easterly direction has resulted in a displacement vertically of the Mt. Babbage strata between 150 and 200 feet. At these highest points only 25 to 30 feet of overmass sediments are represented. It seems most probable therefore that initial sedimentation took place in a lacustrine environment bounded to the east by a fault-line scarp of probable Palaeozoic age. A late Mesozoic transgression succeeding the accumulation of the lower 75-80 feet of clastic sediments resulted in deposition of the coarse micaceous sandstones which are represented in the Mt. Babbage section. From the upper grey quartzite have been obtained impressions of fossil wood and leaves, together with some silicified lamellibranch remains. The coarse angular

character of the lower deposits, cross-bedding, and their obvious derivation from the Precambrian source rocks close by, suggests rapid accumulation of these clastic sediments in a lacustrine intermontane environment. Following the identification of a plant closely related to *Nathorstiana* described previously from Europe as a dune inhabitant, it is possible that the upper 25 to 30 feet of fossiliferous micaceous sandstone and quartzite may represent fossil dune deposits marginal to areas of lacustrine accumulation, which have since been consolidated by processes of secondary silicification. Successive stages in the erosion of these beds may be traced, on the western down-faulted block, from terrace levels, of which four, at approximately 15-20 feet intervals, were identified. Ferruginization and the lithologic similarities of the arenaceous members make specific correlations within this lower dissected area difficult. Correlation of the upper quartzite is possible on the basis of the abundant fossil plant impressions. Correlation of these beds and the ferruginized micaceous sands, grits, and boulder beds east of Mt. Babbage seems justified from lithologic and palaeontologic evidence. These boulder bearing beds underlie the gypsiferous blue-grey shales of lower Cretaceous age, so that, assuming equivalence of the Mt. Babbage sections and these beds, the upper quartzite with plant fossils and lamellibranchs and the underlying micaceous sands and ferruginized grits containing a similar flora are Lower Cretaceous in age and belong to the Blythesdale sandstone.

Late Cainozoic sedimentation is represented by coarse alluvial boulder beds, redistributed duricrust quartzite boulders and aeolian sand deposits which overlie the Mesozoic sediments east of the Flinders Ranges.

III. STRATIGRAPHIC SUCCESSION

1. Precambrian

Sheared tillite (Sturtian), granite, quartz-felspar pegmatite, quartzite, gneisses, schists, etc., form a basement complex in which there is pronounced lineation N. 70° E. The rocks form a granite complex of which Sprigg (1951) discussing the Mt. Babbage Granite Complex states: "To the west the coarsely felspathic types appear to dominate whereas near the south-eastern margin the granite is strongly "gneissic", and at the actual border is highly sheared and silicified. On its southern aspect the granite border parallels the adjacent meta-sedimentary structures fairly faithfully, but elsewhere sedimentary structures run obliquely into the granite. Faulting along the margins is therefore a probability." Bowes (1952) has discussed in detail the petrology of these Precambrian rocks.

2. Lower Cretaceous (Late Neocomian-early Aptian).

Blythesdale Sandstone.

The medium to coarse-grained micaceous sandstones, ferruginized grits and quartzites of the Mt. Babbage area are placed on palaeobotanical evidence as belonging to the Lower Cretaceous. Equivalent sediments, finer grained and less ferruginous, exposed along the banks of the Hamilton Creek and $2\frac{1}{2}$ miles south of Mulo-wurtina consist of coarse cross-bedded sandstones, grits and gravels together with intercalated plant-bearing carbonaceous shales. In the upper portion of these beds boulders, formerly regarded as glacial erratics, occur both *in situ* and scattered over the surface. The close similarity between the flora of Hamilton Creek and Mt. Babbage suggests these strata to be equivalent, and lower Cretaceous in age. The dominantly arenaceous sediments are typically lacustrine in nature, their cross-bedded heterogeneous aspect denoting rapid and turbulent conditions of sedimentation in an environment close to the source rocks. Lateral variations of these sediments are consequently most marked, making specific correlation of individual members very difficult. At Mt. Babbage and in the adjacent eastern tableland the sediments in descending order consist of:

Lithology	Thickness
Massive grey duricrust quartzite capping which weathers into large angular blocks, containing fossil plant impressions and some silicified lamellibranchs (? *Unio* sp.) and passing into a coarse silicified quartz conglomerate at the base. The quartzite is cross-bedded in places and has undergone pronounced secondary silicification - - - -	10–15′
Laminated medium-grained micaceous silty sands with ferruginous bands yellowish-brown in colour; the grains sub-angular to angular are dominantly quartzite in composition; some blue-grey quartz pebbles are included. In places they are mottled purplish-grey to reddish-brown, in colour - -	15′

These sediments, displaced vertically some 150 feet, overlie unconformably the Mt. Babbage Granite complex. The lower members of this section are exposed to the north-west of Mt. Babbage on the downfaulted side, where they are revealed in descending order:

Dark-brown ferruginous angular white quartz pebble conglomerate -	12′
Coarse heterogeneous sub-angular grit, slightly ferruginous with micaceous buff-coloured sandy lenses - - - - - - -	20′
Intercalated grey quartzites and light-brown micaceous sands - -	5′
Massive grey quartzite, strongly jointed in a north-south direction, grading to the south and west into a coarse porcellanised ferruginous grit with white quartz pebble lenses and intercalated quartz grits - -	15′
Interbedded ferruginous dark reddish-brown coarse angular grits, micaceous sandstones and coarse rounded white quartz pebble beds lensing into massive quartzite with intercalated micaceous sand members in the top 5 feet -	18′

A composite section reveals therefore more than 100 feet of these Mesozoic sediments. To the east of the Mt. Babbage tablelands, distant approximately half a mile, further ferruginous grits, and micaceous sands bearing fossil plant remains are exposed unconformably above the Precambrian rocks. In the creek-bed adjacent to Gun Powder Bore are consolidated reddish to buff-coloured sandstones which dip east below the Cretaceous clays. These sediments form part of the section of a series of high cliffs exposed approximately 500 yards to the west. The section revealed from these cliffs consists in descending order of:

(1) Cross-bedded ferruginised gritty sands with a well consolidated dark heterogeneous grit in which are large boulders of porphyry, quartzite, schist, gneiss, etc. The beds have yielded fossil wood and the upper sand below the boulder bed contains organic impressions similar to those of the Mt. Babbage quartzite. - - - - - - -	10′
(2) Laminated fine white relatively unconsolidated quartz sands which are mottled purplish and red with white micaceous sandy shale laminae and pebbly greenish-grey micaceous sands. The thickness of this bed varies predominantly blue-grey and white quartz pebbles. - - - -	13′
(3) Coarse sands and gravel lenses with dark ferruginous bands overlying a basal ferruginous reddish-brown quartz gravel, this lowermost member marking the unconformity with the Precambrian - - - -	8′

Correlation of these sediments has been made with those exposed in the banks of Hamilton Creek, where similar micaceous sands, carbonaceous shales and boulder beds are revealed. A typical section from the river cliffs north of Terrapinna Waterhole reveals in descending order:

(1) Reddish-brown piedmont boulder conglomerates with intercalated gravels overlying unconformity - - - - - - -	15′
(2) Coarse boulder conglomerate marked by a basal bed containing large (5-6 feet) rounded quartzite, granite, gneissic granite, schist, etc., with a finer pebbly matrix, the whole being set in a mottled greenish-grey to brown consolidated silty sand. This passes above into a mottled finer heterogeneous boulder bed with intercalated finer gravelly lenses and at the top pebbly greenish-grey micaceous sands. The thickness of this bed varies considerably laterally - - - - - - - -	4′

(3) Light-brown cross-bedded gypsiferous mottled and banded greyish-brown silty clays with overlying cross-bedded coarse angular quartz gravels, the pebbles averaging approximately ½ inch in diameter and set in a finer sandy matrix - - - - - - - - - 4'

(4) Medium-grained light-brown to grey quartz grit with lensing angular gravel members, the pebbles consisting of quartz and felspar; cross-bedded, carbonaceous in places - - - - - - - - 2'

(5) Coarse ferruginous yellow-brown cross-bedded angular grits with intercalated finer grey sandy lenses The thickness of this member is variable, the top being marked by a dark yellow-brown limonitic band - - 10'

Overlying the Precambrian, west of Muloowurtina woolshed, is the basal member of this succession which consists of a medium-grained relatively unconsolidated yellowish-brown micaceous clastic sandstone with intercalated ferruginised brown limonitic bands and coarse angular grit lenses, the thickness of this member being approximately 10 feet. Overlying this are intercalated micaceous sands, grits, gravels and carbonaceous shales similar to those described above. The sediments vary, laterally, however, the gravelly and carbonaceous units lensing and dividing. The beds are locally folded into shallow anticlines and synclines, the limbs of which dip between 4° and 5°. Lithologically similar quartz grits and gravelly sands exposed along the eastern scarp of the range enable correlation with the boulder-bearing sands described previously by David and Woolnough as a "gritty tillite". These sediments which were regarded as Winton Beds are equivalent to the Hamilton Creek boulder beds from which upper Gondwana plants have been obtained. They consist of yellowish-brown consolidated gritty sandstones overlying unconformably the Precambrian metamorphic complex. Contained in these gritty sands are abundant silicified fossil tree trunks and scattered over the surface are numerous boulders of quartzite, porphyry, gneiss, etc. Only three sizeable boulders were found *in situ* within this bed, one a dark bluish-grey quartzite possibly faceted, one rounded grey quartzite and a roughly triangular quartz felspar rock. The sediments enclosing these boulders consist of clastic quartz, the grains sub-rounded and heterogeneous but of medium coarseness. Intercalated in the lower region of this quartzite are finer sands and soft grey clay lenses averaging 2-5 inches in thickness. The upper limit of the bed consists of a consolidated and ferruginized coarse quartz grit with abundant sub-angular blue-grey quartz pebbles. The base of the bed is marked by a coarse quartz conglomerate, ferruginised and consolidated. This bed has an easterly dip of 11°; strike 330°. The grits lie below the easterly dipping blue-grey, Lower Cretaceous (Roma) clays from which fossiliferous marine limestone nodules have been obtained. No supporting evidence can be found for the previously proposed glacial origin of these boulders in Cretaceous times. The lack of glacial striae, the effects of fluviatile transport, and the proximity of similar rock types in the Flinders Ranges suggests the most probable origin of the boulders to be scree accumulations, redistributed by fluviatile agencies, and deposited marginal to a widespread lacustrine area. Some of the quartzite boulders are identical with erratics now *in situ* in the Sturtian Tillite nearby. Derivation of faceted boulders from this Formation seems the most obvious explanation for their occurrence.

The thickness of the boulder-bearing sands and clays has been estimated at this locality to be 60 feet.

3. Lower Cretaceous (Aptian)
Roma Formation

Fossiliferous blue-grey, yellow and white marine shales of Lower Cretaceous age (Aptian) are exposed extensively in the Muloowurtina area. North of the homestead they have a shallow easterly dip of 2-3°, and form extensive tablelands capped by a hard siliceous Duricrust. Woolnough (1927), discussing this superficial deposit, states:

"All the Duricrust in this locality possesses a more or less well marked concretionary structure. Sometimes this results in spheroidal nodules; but, in some instances, the concretions are much elongated in a direction perpendicular to the original surface. . . . In one place, near Muloowurtina, the average diameter of the nodules is over three feet and they reach a length of at least fifteen feet . . . ."

These features were noted by the writer, but in places the Duricrust above the Cretaceous marine beds is represented as a dense indurated quartzite, and in still further cases as a porcellanised gravel unit.

To the south of Muloowurtina the Cretaceous beds have been extensively folded, the major fold axes trending roughly N.W.-S.E. Easterly dips of up to 35° have been measured, and in cases reverse dips to the west of up to 20° have been introduced. Woolnough (1927) also states:

"In addition to this folding along the strike there has been subordinate dip faulting, so that the Duricrust remnants are disposed 'en echelon'."

The folding of this area thus post-dated the formation of the Duricrust, and has been largely responsible for the formation of the series of low rounded foothills along the eastern Flinders scarp which are overlain by a heavy "gibber" scree of derived Duricrust. North of Muloowurtina the Cretaceous sediments in descending order consist of:

	Lithology	Thickness
(1)	Massive pebbly chert and dense quartzite, grey and stained reddish-brown, with sub-rounded white and grey quartz pebbles - - - -	15'
(2)	Grey silty gypsiferous clays 5-6' which pass transitionally into a severely kaolinised white micaceous soft sandstone with abundant free gypsum. The upper 12 feet of these white beds are mottled pink with small orange-pink crystals of selenite gypsum, bedded and disseminated; some purplish remnants and dark brown ferruginous concretions - - - -	40'
(3)	Yellow gypsiferous clays with limonitic bands and ferruginous lenses and containing the foraminifera *Haplophragmoides dickinsoni* Crespin and *Ammobaculoides romaensis* Crespin, etc. - - - - -	28'
(4)	Dark blue-grey to mottled greenish-brown gypsiferous clays with large plates of selenite gypsum, the clays weathering into powdery greenish-blue detritus. The clays enclose gypsum covered concretions of fine-grained blue-grey dolomitic limestone between 18 inches and 2 feet in diameter. In addition, lower Cretaceous marine fossils, including belemnites (*Peratobelus oxys*) and pelecypods (*Maccoyella* sp.; *Nuculana* cf. *randsi*), were obtained - - - - - - - - -	120' +

South of Muloowurtina where deformation has been more pronounced the upper section has undergone more severe alteration. Here ferruginisation and mottling in shades of red, yellow and mauve obscure the original nature of the sediments. The lower blue-grey shales have also undergone incipient alteration, the ferruginous banding following bedding structures in these sediments. Minor faulting has taken place along lines parallel to the strike of these marine beds.

Gypsum, abundant as both bedded and disseminated masses, is largely of secondary origin, the result of leaching and redeposition during periods of aridity. Fine-grained dolomitic nodules within the beds are surrounded by crystalline gypsum which encloses an intermediate yellow-brown to dark ferruginous layer.

The fauna, while not abundant, definitely indicates a lower Cretaceous (Aptian) age for these sediments. They belong therefore to the Roma Group and not, as previously stated (Woolnough and David, 1926) to the Winton Beds.

Late Cainozoic — Recent

Piedmont boulder beds, alluvial clays and aeolian sand deposits overlie the Mesozoic sediments east of the Flinders Ranges. Downcutting by Hamilton Creek has exposed more than 15 feet of coarse boulder conglomerates and reddish-brown

clays unconformably overlying the Mesozoic sediments. Dissection and breaking up of the "Duricrust" has resulted in the accumulation of coarse chert "gibbers" in areas formerly overlain by this bed.

IV. STRATIGRAPHIC POSITION OF THE PLANT-BEARING SEDIMENTS

The lowermost Cretaceous deposits described from the Great Artesian Basin are terrestrial strata, dominantly arenaceous in composition with subordinate coal-bearing phases. These sediments, defined originally by Lockhart Jack (1895) as the "Blythesdale Braystones" underlie the Rolling Downs Formation (Aptian-Cenomanian):

"In mapping the eastern limit of the Lower Cretaceous formation we find that at the base there is a series of soft grey very friable limestones, grits and conglomerates. . . . . To this rock we felt it necessary to give a distinctive name, the 'Blythesdale Braystone', as it is well developed at Blythesdale near Roma . . .

"Hitherto it has been convenient to speak of the beds designated the Blythesdale Braystone as being of similar composition throughout. This, however, is not the case, as the braystone of normal composition is 'parted' in places by beds of sandy shale and calcareous sandstone. We may imagine coarse sandy and gravelly sediments brought down to the margin of a shallow lower Cretaceous sea by numerous tributary rivers and spread out along the shore and out to sea by the action of waves and currents. The sea in which the Blythesdale Braystone was deposited . . . . . was very shallow throughout . . . . swept from end to end by currents . . . . sufficiently powerful . . . . to account for the wide distribution of the sand and gravel which is evidenced by the Artesian Wells."

The sediments become paralic in their upper development (Whitehouse, 1952). The Blythesdale Sandstone is known in South Australia principally from Stuarts Range and south-east of Lake Eyre, where it has been regarded as basal Cretaceous and/or Upper Jurassic in age. (Recent foraminiferal investigations from bore cores by Miss I. Crespin (1945) have yielded a number of foraminifera from "carbonaceous shales and sandstones" which are of lower Cretaceous age but the stratigraphic position of these sediments is not clearly indicated).

In the Orallo and Yingerbay districts, Queensland, the Blythesdale beds have been recognised as late Neocomian—early Aptian in age (Whitehouse (1952 p. 97)). The non-calcareous upper Blythesdale is succeeded by the calcareous Rolling Downs Formation, but there is no initial time break.

The lower sequence of coarse arenaceous grits, sands, gravels and interbedded carbonaceous shales and boulder beds of Muloowurtina are ascribed to the lower Cretaceous and are considered as equivalents of the Blythesdale Sandstones. As in the case of the more fully developed Queensland deposits the upper Blythesdale has a paralic development in this locality, intercalated blue-grey shale bands forming between the gritty sandstone members in the upper part of the section. The arenaceous beds are overlain conformably by the Aptian marine shales and no time break is indicated from geologic evidence. Also the presence of a late Mesozoic flora, including lycopod stigmaria related to those from European Lower Cretaceous deposits, supports the contention that these beds are of similar age.

Stratigraphic correlation of these strata is made with a sequence of coarse ferruginous sands, grits, gravels and plant-bearing quartzites which overlie unconformably Precambrian rocks and are themselves conformably overlain by the Roma beds at Algebuckina Hill west of Lake Eyre. The sediments examined earlier by the writer represent exposures from the Blythesdale Sandstones recognised previously from Stuarts Range and south-east of Lake Eyre. Interbedded coarse sandstones and subordinate clay shales underlying lower Cretaceous marine

beds and regarded by Whittle (1952) as Jurassic, more probably represent the basal Cretaceous Blythesdale Sandstones.

It should be noted that although the so-called Eyrian (early Tertiary) beds of Mt. Babbage (Woolnough and David, 1926) have now conclusively been shown as Lower Cretaceous in age, the presence of Tertiary continental deposits has been proved from subsurface investigations by Lockhart Jack (1925) at Cordillo Downs, where 365 feet of dominantly arenaceous sediments overlie unconformably lignite-bearing upper Cretaceous beds.

V. PALAEONTOLOGY

Identification of the plant fossils from the Blythesdale sandstone formation (Glaessner and Rao, 1955) are listed below:

Nathorstianella babbagensis (H. Woodward). Locality: Mt. Babbage.

Cladophlebis australis (Morris). Locality: Woolshed section, Muloowurtina and two miles north-east of Flinders No. 5 talc mine.

Taeniopteris spatulata McClelland. Locality: Flat-topped hill about ½ mile north-east of Mt. Babbage and Woolshed section, Muloowurtina station.

Otozamites bengalensis (Oldham and Morris). Locality: Flat-topped hill about ½ mile north-east of Mt. Babbage.

Cycadites sp. Locality: Woolshed section, Muloowurtina.

Nilssonia schaumburgensis (Dunker). Locality: Woolshed section, Muloowurtina. (Collected by Miss M. J. Wade.)

Elatocladus planus (Feistmantel). Locality: Flat-topped hill about ½ mile north-east of Mt. Babbage.

In addition to this flora, fossil wood specimens have been collected from Mt. Babbage, Hamilton Creek and 2½ miles south of Muloowurtina station.

The following invertebrate fossils have been provisionally identified by V. R. Rao:

Unio sp.: From quartzite belonging to the Blythesdale Sandstone. Locality: Mt. Babbage.

Peratobelus oxys (Tenison Woods) and *Maccoyella* cf. *barklyi* Moore. From blue clays of the Roma formation. Locality: ½ mile north of Muloowurtina station.

Nuculana cf. *randsi* Ethridge. From blue clays of the Roma Formation. Locality: 2½ miles south of Muloowurtina station.

Ammobaculoides romaensis Crespin and *Haplophragmoides dickinsoni* Crespin. Arenaceous foraminifera found in yellow clays of Roma Formation. Locality: 1¼ miles north-west of Muloowurtina station.

VI. REGIONAL CORRELATION

1. Billy Springs area

West of Muloowurtina, ferruginous grits, micaceous shaly sandstones and pebble conglomerates have been deposited in isolated shallow lacustrine basins. Concerning the Billy Springs area Sprigg (1951) states: "A small outlier of sandstones . . . . has been noted by S. B. Dickinson on a low divide about one mile N.E. of Billy Springs. The sediments contain vegetable matter, but at present their age is unknown. . . . . the material has the appearance of certain Jurassic sandstones but . . . . many Tertiary sandy beds preserved in the adjacent Frome sunklands, appear similar."

The sediments which were examined by the writer consist of finely laminated buff to pale-brown micaceous sands with intercalated gritty and pebbly lenses, the thickness exceeding 30 feet. The sediments are lithologically similar to the

micaceous sands underlying the fossiliferous quartzite of Mt. Babbage. Lithologic similarity of these beds with the Mt. Babbage section suggests them to be of the same age (Lower Cretaceous).

2. West of Flinders Ranges

Bordering the western foothills of the Flinders Ranges high tablelands reveal in descending order:

	Lithology	Thickness
(1)	Massive grey "Duricrust" chert with subordinate gypsum - - -	+ 10'
(2)	Blue-grey gypsiferous clay shales laminated yellow-brown and ferruginised	7'
(3)	Dark-brown limonitic band - - - - - - - -	6'
(4)	Fine cross-bedded yellow-brown to buff quartz grits passing into laminated red and brown ferruginous quartz sands - - - - -	20'
(5)	Laminated grey to yellow-brown fine micaceous silty sandstones, semi-consolidated with occasional quartz and shale pebbles and carbonaceous shale lenses yielding lignitic fragments and leaf impressions of *Cladophlebis australis* (Morris) - - - - - - -	6'
(6)	Blue-grey micaceous silty clays with disseminated gypsum and bands of consolidated yellow-brown limonitic iron, grading transitionally into laminated yellow-brown sandy clay shales - - - - -	28'
(7)	Dark-brown micaceous gritty sandstone with intercalated pebbly lenses and ferruginous bands - - - - - - - -	+ 3'
	Total exposed thickness - - - -	+ 74'

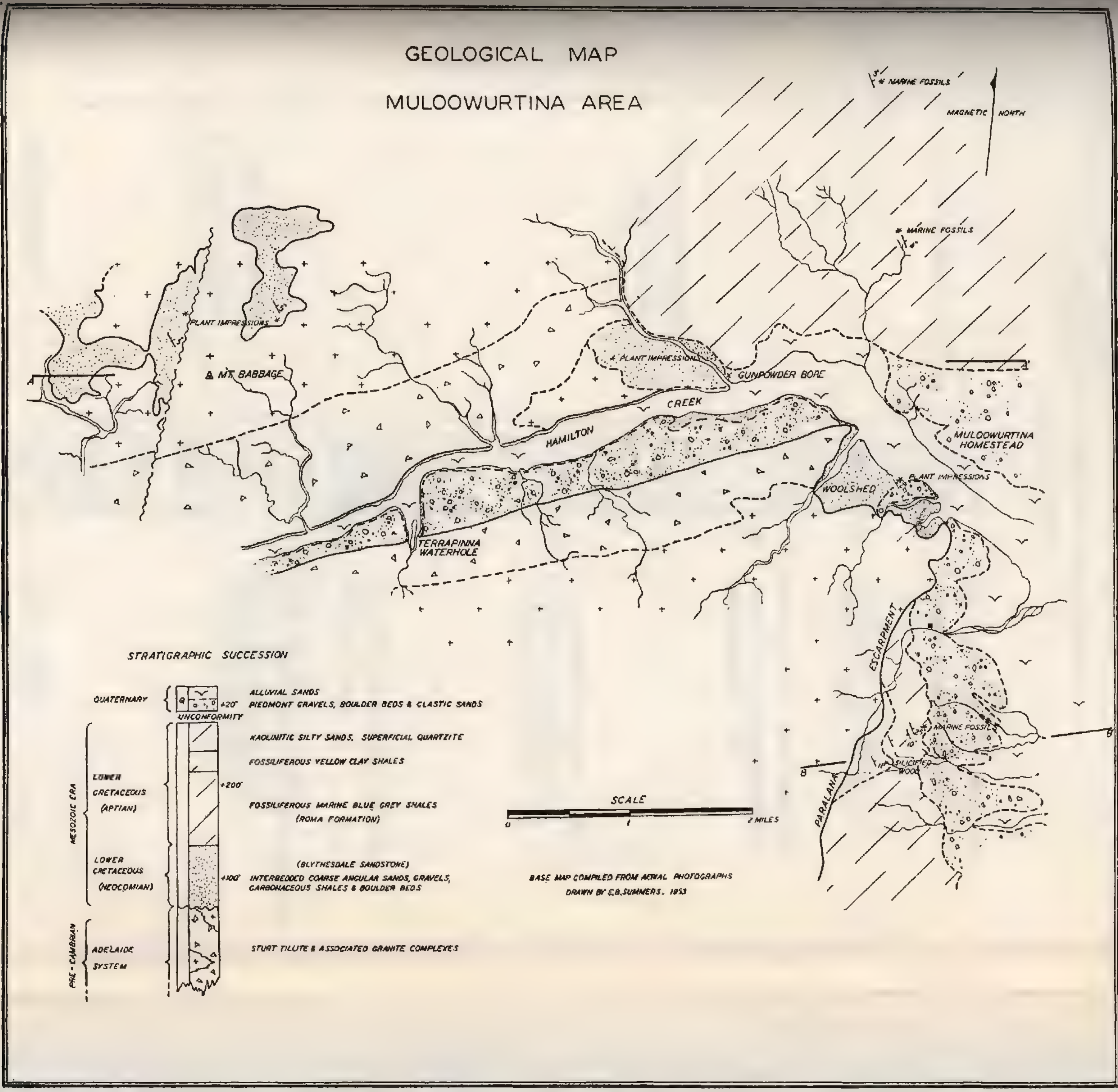
The presence of *Cladophlebis australis* indicates that these sediments may be of Upper Jurassic–Lower Cretaceous age. These lacustrine deposits have a gentle westerly dip which conforms with the main direction of current bedding, indicating the sediments to have been deposited in a widespread region of depression marginal to the Precambrian source rocks of the Flinders Range.

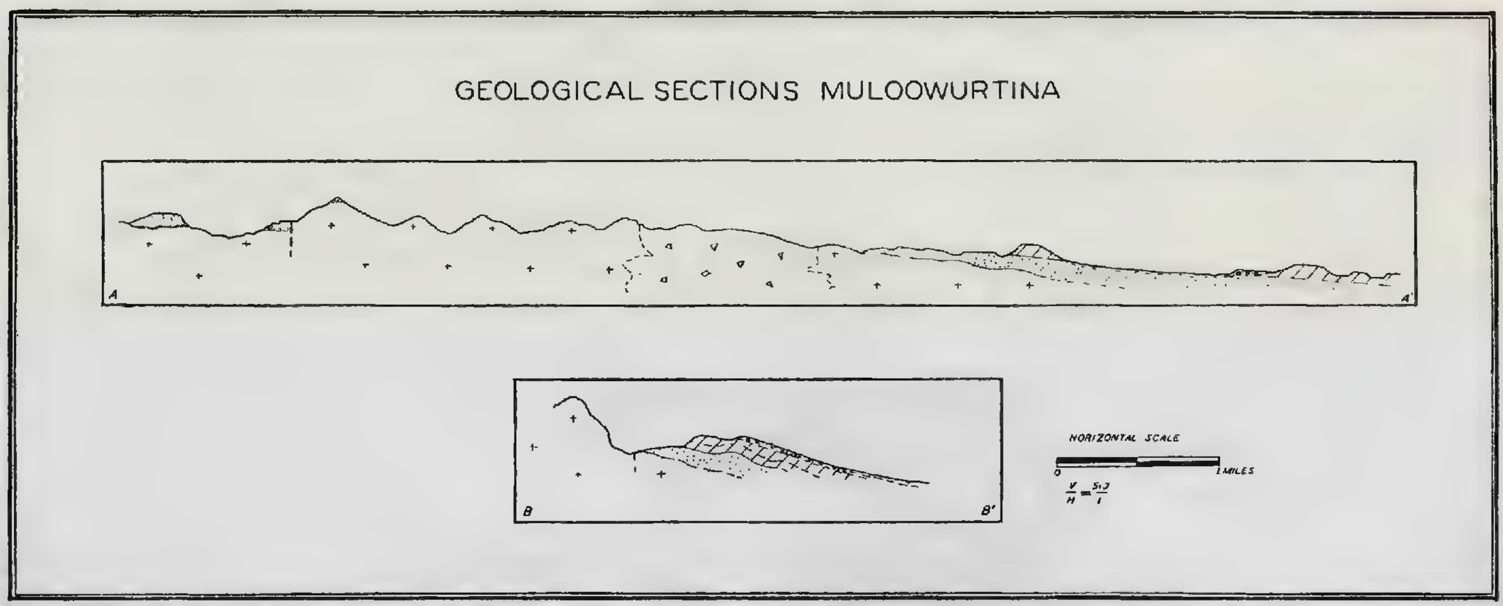
3. One Mile South of Copley Township

Seventy-one feet of current bedded lacustrine sediments tentatively classed as Jurassic (Parkin 1953) overlie Triassic coal-bearing beds one mile south of Copley. The sediments in descending order are:

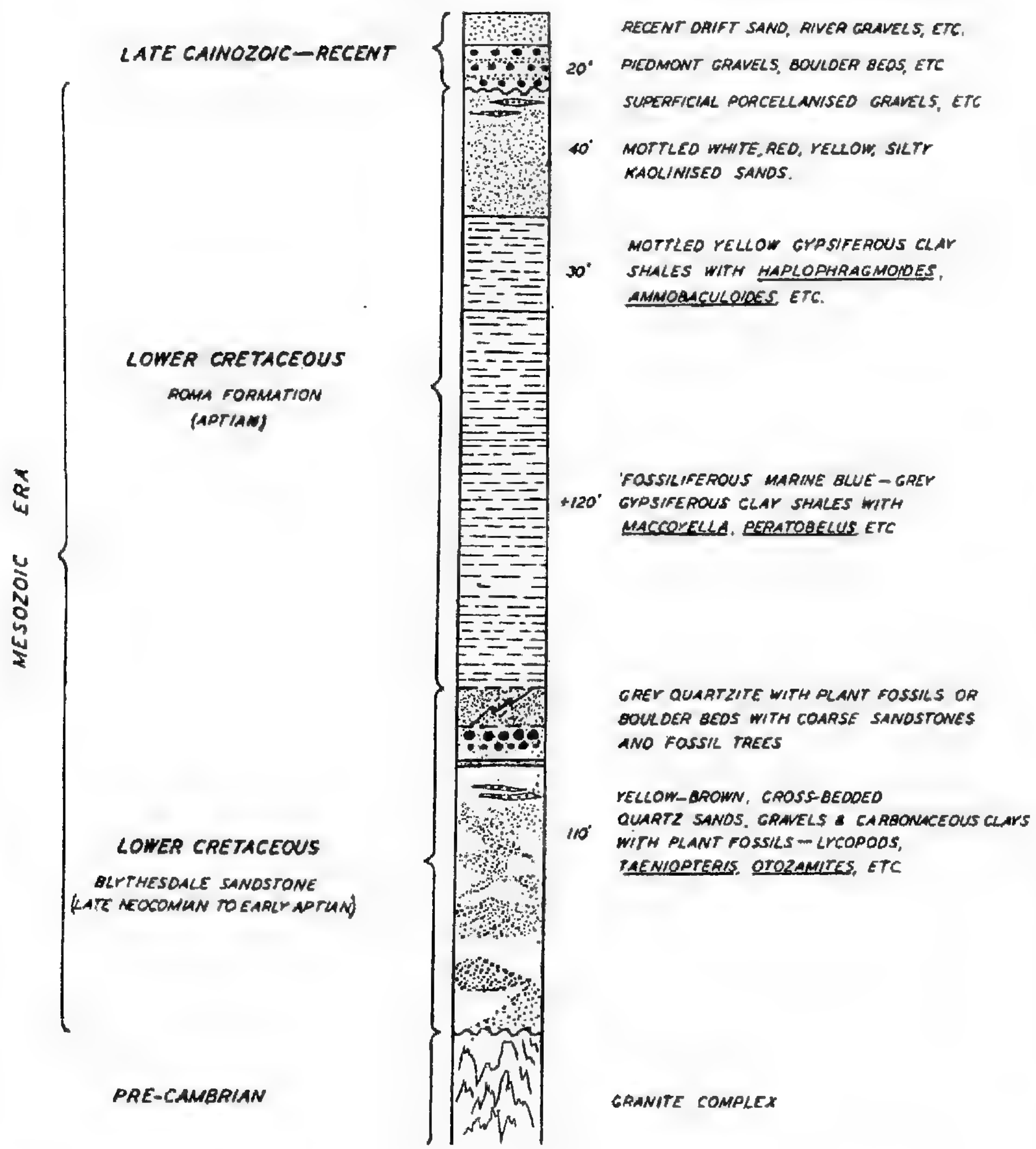
	Lithology	Thickness
(1)	Grey chert cementing quartz "Duricrust" capping containing impressions of fossil wood, plants, etc. - - - - - - -	+ 10'
(2)	Coarse current-bedded buff to yellow-brown micaceous quartz grits becoming ferruginous and consolidated at the surface, the grains sub-angular. In this bed are intercalated white micaceous fine-grained, sandy shale bands 3-4" in thickness with gritty laminae and some fossil wood impressions. At the base are silty kaolin bands with a coarse gravel bed of cemented slate, chert, and quartzite boulders - - - - - - -	40'
(3)	Coarse cross-bedded micaceous purple quartz grits with intercalated gravel lenses, white sands and kaolin nodules - - - - -	12'
(4)	Basal conglomerate, dark purple in colour of variable thickness showing cut and fill effects and marking the unconformity with the underlying Precambrian slates - - - - - - - -	9'

While confirmatory evidence of a Jurassic age for these deposits is lacking, the presence of fossil wood remains similar to those from Mt. Babbage and other areas, and the lithologic character of the deposits suggests them to correspond to the widespread lacustrine accumulations of Jurassic-Cretaceous age described above. Torrential stream deposition is clearly evidenced by the pronounced current bedding and coarse clastic nature of the sediments.


GEOLOGICAL MAP
MULOOWURTINA AREA
MARINE FOSSILS
MAGNETIC NORTH
MARINE FOSSILS
PLANT IMPRESSIONS
MT. BABBAGE
PLANT IMPRESSIONS
GUNPOWDER BORE
HAMILTON
CREEK
MULOOWURTINA HOMESTEAD
PLANT IMPRESSIONS
WOOLSHED
TERRAPINNA WATERHOLE
ESCARPMENT
PARALANA
MARINE FOSSILS
SILICIFIED WOOD
STRATIGRAPHIC SUCCESSION
QUATERNARY
Q
+20'
ALLUVIAL SANDS
PIEDMONT GRAVELS, BOULDER BEDS & CLASTIC SANDS
UNCONFORMITY
MESOZOIC ERA
LOWER CRETACEOUS (APTIAN)
KAOLINITIC SILTY SANDS, SUPERFICIAL QUARTZITE
FOSSILIFEROUS YELLOW CLAY SHALES
+200'
FOSSILIFEROUS MARINE BLUE GREY SHALES
(ROMA FORMATION)
LOWER CRETACEOUS (NEOCOMIAN)
(BLYTHESDALE SANDSTONE)
+100'
INTERBEDDED COARSE ANGULAR SANDS, GRAVELS, CARBONACEOUS SHALES & BOULDER BEDS
PRE-CAMBRIAN
ADELAIDE SYSTEM
STURT TILLITE & ASSOCIATED GRANITE COMPLEXES
SCALE
0
1
2 MILES
BASE MAP COMPILED FROM AERIAL PHOTOGRAPHS
DRAWN BY C.B. SUMMERS. 1953


GEOLOGICAL SECTIONS MULOOWURTINA
A
A'
B
B'
HORIZONTAL SCALE
0
1 MILES

GENERALISED STRATIGRAPHIC COLUMN
MULOOWURTINA



ACKNOWLEDGMENTS

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THE MOLLUSCAN FAUNA OF THE PLIOCENE STRATA UNDERLYING THE ADELAIDE PLAINS
PART II - PELECYPODA

*BY N. H. LUDBROOK**

Summary

Part II of the study of the mollusca recovered from borings into the Dry Creek Sands of Pliocene age consists of a systematic revision of the Pelecypoda. The nomenclature of 120 species has been completely revised and 20 species described as new. One new name is introduced.

The geological and environmental background of the fauna, together with an analysis of its relationships with molluscan faunas outside Australia, was discussed in Part I, published in the Transactions of the Society, 77, pp. 42-64, 1954. A map showing the position of the bores from which material was examined was included in Part I.

THE MOLLUSCAN FAUNA OF THE PLIOCENE STRATA UNDERLYING THE ADELAIDE PLAINS

PART II — PELECYPODA

By N. H. Ludbrook *

[Read 13 May 1954]

SUMMARY

Part II of the study of the mollusca recovered from borings into the Dry Creek Sands of Pliocene age consists of a systematic revision of the Pelecypoda. The nomenclature of 120 species has been completely revised and 20 species described as new. One new name is introduced.

The geological and environmental background of the fauna, together with an analysis of its relationships with molluscan faunas outside Australia, was discussed in Part I, published in the Transactions of the Society, 77, pp. 42-64, 1954. A map showing the position of the bores from which material was examined was included in Part I.

INTRODUCTION

In the following systematic study, diagnoses of species have been made, where possible, from the holotypes. Where the holotype was not available, the diagnosis has been made from specimens found in borings made available to the writer. Similarly, dimensions cited are, wherever possible, those of the holotype.

Abbreviations o.d. for original designation and s.d. for subsequent designation of type species have been employed throughout.

Collections in which specimens are lodged are abbreviated as hereunder:

Tate Mus. Coll., Univ. of Adelaide, for Tate Museum Collection, University of Adelaide.
S. Aust. Mines Dept. Coll., for Collection of the South Australian Mines Department.
S. Aust. Mus. Coll., for South Australian Museum Collection, Adelaide.
Aust. Mus. Coll., for Australian Museum Collection, Sydney.
Nat. Mus. Coll., for National Museum Collection, Melbourne.
Geol. Surv. Coll., for Collection of the Geological Survey of Victoria, Melbourne.
Melb. Univ. Geol. Dept., for Collection of the Geology Department, University of Melbourne.
B.M. Coll., for British Museum (Natural History) Collection, London.

Class **PELECYPODA**

Order **FILIBRANCHIA**

Family NUCULIDAE

Genus Nucula Lamarck, 1799

Nucula Lamarck, 1799, Mem. Soc. Hist. Nat., Paris, p. 87
Type species (Monotypy) *Arca nucleus* Linné

Subgenus Ennucula Iredale 1931

Ennucula Iredale, 1931, Rec. Aust. Mus., **18**, (4), p. 202.
(*Eunucula* Iredale. Cotton, 1947, Rec. S.A. Mus., **8**, (4), p. 655, 656, *lapsus calami* for *Ennucula*).

Type species (o.d.) *Nucula obliqua* Lamarck

Nucula (Ennucula) kalimnae Singleton,
pl. 1, fig. 1, 2

Nucula tumida Tenison Woods, Tate, 1886, Trans. Roy. Soc. S. Aust., **8**, p. 127, pl. 6, fig. 6a, 6b.
Nucula tenisoni Pritchard. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 146.
Nucula obliqua Lamarck. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Nucula kalimnae Singleton, 1932. Proc. Roy. Soc. Vict., **44**, (n.s.), (2), p. 292-94, pl. 24, fig. 7-9.

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* Department of Mines, Adelaide.

Diagnosis—Shell relatively large, heavy, moderately inflated; anterior hinge area gently arcuate, less arched than in the Recent *N. obliqua;* inner ventral margin sometimes obscurely crenulate.

Dimensions—Length 20·5; height 15; thickness (right valve) 6·5 mm.

Type Locality—Cutting on main road above bridge, Jemmy's Point, Kalimna, Victoria; Lower Pliocene.

Location of Holotype—No. 1312, Melb. Univ. Geol. Dept.

Observations—Adelaide specimens are smaller and less heavy than the Gippsland Lakes holotype, but approximate more closely to *kalimnae* than to *obliqua,* which is a broader and less tumid shell, more arched on the anterior dorsal margin. The writer agrees with Singleton that the differences exhibited by Muddy Creek (and also Adelaide) shells are not of sufficient magnitude to warrant specific distinction. There is a lineal descent from *N. tenisoni* through *N. kalimnae* and its Muddy Creek, Adelaide, and Werrikooian examples, in that order, to the Recent *N. obliqua,* with which Adelaide specimens have been previously identified.

Material—7 valves, maximum dimensions length 11 mm., height 8 mm., from Weymouth's Bore.

Stratigraphical Range—Lower to Upper Pliocene.

Geographical Distribution—Gippsland, Victoria, to Adelaide, South Australia.

Nucula (Ennucula) beachportensis Verco

pl. 1, fig. 3, 4

Nucula beachportensis Verco, 1907. Trans. Roy. Soc. S. Aust., 31, p. 216, pl. 27, fig. 3.
Ennucula beachportensis Verco. Cotton and Godfrey, 1938. Moll. S. Aust., p. 41, text fig. 14

Diagnosis—Very small, anterior dorsal margin straight and elongate, posterior margin short and somewhat truncate, ventral border uniformly curved. Umbo at about posterior one-sixth. Inner margin minutely crenulate.

Dimensions—Length 4·9, height 4·6 mm.

Type Locality—Off Beachport, 40 fathoms. Recent.

Location of Holotype—S. Aust. Mus. Reg. No. D 11310.

Observations—This is a very small species, recorded fossil for the first time. It is distinguishable by its elongate posterior margin and finely crenulate inner ventral margin.

Material—One complete specimen, 10 valves, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—Tasmania; Beachport to Cape Jaffa, South Australia.

Nucula (Ennucula) venusta N. H. Woods

pl. 6, fig. 1

Nucula venusta N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 147, pl. 7, fig. 2.

Diagnosis—Solid, ventricose, umbo very prominent, inclined markedly to posterior. Ventral margin flattened or obsoletely denticulate.

Dimensions—Length 5·6, height 4·8 mm.

Type Locality—Abattoirs Bore, Adelaide, South Australia; Pliocene.

Location of Holotype—Tate Mus. Coll. Univ. of Adelaide. T 1678

Observations—The one perfect left valve is of approximately the same size as the holotype from the Abattoirs Bore. The chondrophore is very oblique (almost horizontal), narrow, and deeply grooved. The inner ventral margin is obsoletely denticulate.

Material—Holotype; four left valves, one almost perfect, and two right valves from Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

Genus Pronucula Hedley, 1902

Pronucula Hedley 1902. Mem. Aust. Mus., 4, (5), p. 290

Type species (o.d.) *Pronucula decorosa* Hedley

Pronucula morundiana Tate

Nucula morundiana Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 128.
Nucula morundiana Tate. Dennant and Kitson, 1903. Rec. Geol. Vict., **1**, (2), p. 122.
Nucula morundiana, Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Pronucula morundiana Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 655.

Diagnosis—Shell minute, tumid, trigonal, inner margin of valves minutely denticulate, surface sculptured with fine, equal, concentric ribs.

Dimensions—Length 3, height 3, thickness through both valves 2 mm.

Type Locality—River Murray Cliffs near Morgan, South Australia; Lower Miocene.

Location of Holotype—Tate Mus. Coll. Univ. of Adelaide. T 1042A.

Observations—Adelaide material so far examined is very poorly preserved and it is doubtful whether this species is *morundiana*.

Material—1 valve, Hindmarsh Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide, South Australia.

Family NUCULANIDAE

Genus Nuculana Link, 1807

Nuculana Link, 1807. Beschr. Nat. Samml. Univ. Rostock, (3), p. 155

(*Leda* Schumacher, 1817. Ess. Vers. test., p. 55, 173)

Type species (monotypy) *Arca rostrata* Gmelin

Subgenus Scaeoleda Iredale, 1929

Scaeoleda Iredale, 1929c. Rec. Aust. Mus., 17, (4), p. 158

Type species (o.d.) *Leda crassa* Hinds

Nuculana (Scaeoleda) woodsi (Tate)

pl. 1, fig. 5.

Leda inconspicua Tenison Woods, 1878. Proc. Linn. Soc. N.S.W., **3**, p. 139, pl. 21, fig. 3.
Leda woodsii Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 133, pl. 9, fig. **8**.
Leda woodsii Tate, Tate and Dennant, 1893. Trans. Roy. Soc. S. Aust., **17**, (1), p. 224.
Nuculana woodsii Tate (sp.). Harris, 1897. Cat. Tert. Moll. Brit. Mus., p. 349.
Leda woodsii Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 122, 138.
Nuculana woodsii Tenison Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.

Diagnosis—Small compressed, with angular posterior ridge from umbo to ventral margin; surface finely ribbed, ribs passing over ridge.

Dimensions—Length 12, height 6; thickness through both valves 3·5 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; (?) Lower Miocene.

Location of Holotype—Tate Mus. Coll. Univ. of Adelaide. T 1039.

Material—Two complete specimens, 5 valves, Hindmarsh Bore, 450-487 feet. 7 valves, Weymouth's Bore, 310-330 feet.

Stratigraphical Range—? Oligocene to Pliocene.

Geographical Distribution—Victoria, Tasmania, South Australia.

Nuculana (Scaeoleda) crebrecostata (Tenison Woods)

pl. 1, fig. 6

Leda crebrecostata Tenison Woods, 1877. Proc. Roy. Soc. Tas. for 1876, p. 112.
Leda crebrecostata Tenison Woods. Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 133, pl. 5, fig. 5 a-b.
Leda crebrecostata T. Woods. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 123.
Nuculana crebrecostata T. Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.

Diagnosis—Trigonal, oblong, angular, gaping. Posterior area markedly depressed, cut off by narrow ridge from umbo to ventral margin. Surface sculptured with numerous fine lirae interrupted by ridge.

Dimensions—Length 8, height 5, thickness through both valves 3 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—Roy. Soc. Coll., Tasmania.

Material—Four valves, Abattoirs Bore.

Stratigraphical Range—? Oligocene to Pliocene.

Geographical Distribution—Table Cape, Tasmania; Spring Creek, Victoria; Adelaide, South Australia.

Nuculana (Scaeoleda) verconis (Tate).

pl. 1 fig. 7

Leda verconis Tate, 1891. Trans. Roy, Soc. S. Aust., for 1890, **14**, p. 264, pl. 11, fig. 4.
Nuculana verconis Verco. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 147, 150.

Diagnosis—Elongate-ovate, posterior side shortly acuminated, with slightly curved keel. Surface sculptured with about 30 concentric lirae slightly incurved towards the posterior margin.

Dimensions—Length 8, height 5, thickness through both valves 3·5 mm.

Type Locality—Yankalilla Bay, South Australia; Recent.

Location of Holotype—S. Aust. Mus. Reg. No. D 11340.

Material—Two valves, Weymouth's Bore; 5 valves, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—South Australia.

Superfamily ARCACEA
Family ARCIDAE
Genus ARCA Linné, 1758

Arca Linnē 1758. Syst. Nat. ed. 10, 1, p. 693.
Arca Linné. Reinhart, 1935. Mus. Roy. d'Hist. nat. Belg., 11, (13), p. 14 (Synonymy).
Type species (s.d. I.C.Z.N. 1945) *Arca noae* Linné

Arca negata Cotton

Arca navicularis Brug. Tate, 1890 a. Trans. Roy. Soc. S. Aust., **13**, (2), p. 175.
Arca navicularis Brug. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 146.
Arca navicularis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Arca negata Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 656, pl. 20, fig. 11, 12.

Diagnosis—Umbones distant, acute, sharp ridge from umbo to posterior ventral margin; sculpture of fine, close radial ribs anterior to angle about 7 per mm.; cancellate in young stages.

Dimensions—Length 24, height 11 mm.

Type Locality—Bore 65, 385-395 feet, Adelaide, South Australia; Pliocene.

Location of Holotype—S. Aust. Mus. Coll., No. 8361.

Material—Holotype; 1 right valve, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore; Bore 65.

Genus BARBATIA Gray, 1842
Barbatia Gray, 1842. Syn. Cont. Brit. Mus., p. 81
Type species (s.d. Gray, 1847) *Arca barbata* Linné
Subgenus BARBATIA s. str.

Barbatia (Barbatia) epitheca Cotton

Arca (Barbatia) pistachia Lamarck. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Barbatia epitheca Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 657, pl. 20, fig. 14, 17.

Diagnosis—Subquandrangular, anterior rounded, posterior longer and obliquely truncate, surface sculpture of fine and numerous radials crossed by equal concentrics.

Dimensions—Length 23, height 12 mm.

Type Locality—Abattoirs Bore, Adelaide, South Australia; Pliocene.

Location of Holotype—S. Aust. Mus. Coll., No. 8313.

Observations—The species described by Cotton is, according to its author (personal communication), smaller, longer, and more finely sculptured than the Recent *pistachia* with which it was originally identified.

Material—Holotype.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore.

Subgenus Acar Gray, 1857

Acar, Gray, 1857. Ann. Mag. Nat. Hist., ser. 2, **19**, p. 360.

Type species (s.d. Woodring, 1925) *Arca gradata* Broderip and Sowerby

Barbatia (Acar) coma (Cotton)

Acar coma Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 657, pl. 20, fig. 25, 26.

Diagnosis—Subquadrangular, umbones close, sculpture of radial flattened ribs crossed by frilled lamellae.

Dimensions—Length 23 mm., height 10 mm.

Type Locality—Weymouth's Bore, 345-350 feet; Pliocene.

Location of Holotype—S. Aust. Mus., No. 8404.

Material—Two left valves, Weymouth's Bore, 310-330 feet.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's Bore, Adelaide.

Genus Cucullaea Lamarck, 1801

Cucullaea Lamarck, 1801. Syst. Anim. sans Vert., p. 116

Type species (s.d. Schmidt, 1818) *Cucullaea auriculifera* Lamarck = *Arca concamera* Bruguière

Cucullaea corioensis McCoy

pl. 1, fig. 8, 9

Cucullaea coriensis McCoy, 1876. Prod. Pal. Vict., 3, p. 32, pl. 27, fig. 4, 5.
Cucullaea corioensis McCoy. Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 144.
Cucullaea corioensis McCoy. Johnston, 1888. Geol. Tas., pl. 29, fig. 4, 4 a.
Cucullaea corioensis McCoy. Tate and Dennant, 1893. Trans. Roy. Soc. S. Aust., **17**, (1), p. 224.
Cucullaea corioensis McCoy. Pritchard, 1896. Proc. Roy. Soc. Vict., **8**, (n.s.), p. 131.
Cucullaea corioensis McCoy. Harris, 1897. Cat. Tert. Moll. Brit. Mus., **1**, p. 336.
Cucullaea corioensis McCoy. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), pp. 122, 138, 145 (*pars*).
Cucullaea corioensis McCoy. Chapman and Gabriel, 1914. Proc. Roy. Soc. Vict., **26**, (2), (n.s.), p. 302.
Cucullaea corioensis McCoy. Singleton, 1932. Proc. Roy. Soc. Vict., **44**, (n.s.), (2), p. 300-303.

Diagnosis—Large, heavy, obliquely trapezoidal; ratio anterior to posterior part of hinge generally less than 1. Sculpture of fine radiating ridges, 3 per mm. at 8 mm. from umbo, crossed by closely spaced growth lines with undulations on the ribs.

Type Locality—Bird Rock, near Spring Creek, Victoria.

Location of Holotype—National Museum, Melbourne.

Material—Five complete, 1 broken valve, Weymouth's Bore; 13 valves, Lower Beds, Muddy Creek, L4789, L6598, L42238-42, 70411, B.M. Coll. 1 valve Werribee, Victoria; 5 valves River Murray, South Australia.

Stratigraphical Range—? Oligocene to Pliocene (F.A.S., N.H.L.).

Geographical Distribution—Victoria, Tasmania, South Australia.

Cucullaea praelonga Singleton

pl. 5, fig. 15

Cucullaea corioensis McCoy, 1876. Prod. Pal. Vict., 3, pl. 27, fig. 3 (?), 3 a (*non* 4, 5).
Cucullaea corioensis McCoy. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 138.
Cucullaea corioensis praelonga Singleton, 1932. Proc. Roy. Soc. Vict., **44**, (n.s.), (2), p. 303-304, pl. 26, fig. 20 a, b.
Cucullaea praelonga (Singleton 1932). Singleton, 1945. Proc. Roy. Soc. Vict., **56**, (n.s.), (2), p. 257.
Cucullaea praelonga Singleton, Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 658.

Diagnosis—Less inequilateral than *corioensis*, less tumid, ratio anterior to posterior part of hinge greater than 1.

Dimensions—Length 61·5, height 51, inflation (right valve) 21 mm.; length anterior to hinge 7·5, of hinge 42·5, posterior to hinge 11·5; maximum height of hinge from ventral border 43·5 mm. Ratio of anterior to posterior part of hinge 1·13.

Type Locality—Forsyth's, Grange Burn, near Hamilton, Victoria; Lower Pliocene.

Location of Holotype—No. 1320 Melbourne University Geology Department.

Observations—Cotton (1947) has recorded this species from the Dry Creek Sands, although the exact locality is not specified. He remarks that specimens are common in the "Adelaidean" and appear to be *praelonga* rather than *corioensis*. With the exception of one sample from Kooyonga Bore, the specimens examined satisfy the general criterion for *corioensis* established by Singleton (1931, p. 302); *i.e.*, the ratio anterior : posterior part of hinge is less than 1. The writer is therefore in agreement with Singleton that Adelaide examples are *corioensis*. It seems possible that one true species only is represented, and that *praelonga* is, as originally described, merely a subspecies of *corioensis*. A wider range of specimens, numerically and geographically, should be examined to determine statistically whether two species are present or not.

Material—1 valve, Kooyonga Bore.

Stratigraphical Range—Lower Pliocene and Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria; Adelaide, South Australia.

Family LIMOPSIDAE

Genus LIMOPSIS Sassi, 1827

Limopsis Sassi, 1827. Giorn. Ligust., 1, (5), p. 476.
(*Trigonocoelia* Nyst and Galeotti, 1835, Bull. Acad. Roy. Bruxelles, 2, p. 289.)
(*Pectunculina* d'Orbigny, 1844. Pal. France, Cret., 3, (Lam.), p. 182.)
(*Cosmetopsis* Rovereto, 1898, Atti Soc. Ligust., 9, pp. 162, 177.)

Type species (s.d, Gray, 1847) *Arca aurita* Brocchi

Subgenus LIMOPSIS s. str.

(*Versipella Iredale*, 1931. Rec. Aust. Mus., 18, p. 203.)

Limopsis (Limopsis) beaumariensis Chapman

pl. 5, fig. 7

Limopsis forskali A. Adams. Tate, 1897. Trans. Roy. Soc. S. Aust., 21, p. 58.
Limopsis forskali A. Adams. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 122 (in part), p. 138, 146.
Limopsis beaumariensis Chapman, 1911. Proc. Roy. Soc. Vict., 23, (n.s.), (2), p. 423-5, pl. 84, fig. 6; pl. 85, fig. 12.
Limopsis beaumariensis Chapman. Chapman, Crespin, and Keble, 1928. Rec. Geol. Surv. Vict., 5, (1), p. 152.
Limopsis beaumariensis Chapman, N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.
Limopsis affinitalis Chapman. N. H. Woods, *ibid.*
Limopsis beaumariensis Chapman. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 93.

Diagnosis—Subtrigonal, hinge line strongly arched; sculptured with slightly undulating primary riblets with from 0 to 4 secondary riblets between, crossed by less conspicuous growth lines.

Dimensions—Length 21, height 20·25, inflation (1 valve) 6, length of hinge line 9·25; height of ligament pit 1·75 mm.

Type Locality—Beaumaris, Victoria; Lower Pliocene.

Location of Holotype—Geol. Surv. Vic. Coll.

Observations—Although some of the "genera" created by Iredale in 1929 and 1931 for species of *Limopsis* are separable from *Limopsis* s. str., *Versipella* created for *Limopsis tenisoni* Tenison-Woods appears to have no recognizable morphological characters to separate it from the type species *Limopsis surita* Brocchi. *Versipella* is therefore considered a synonym of *Limopsis* s. str.

Material.—Twelve valves, Weymouth's Bore, 2 valves Abattoirs Bore.

Stratigraphical Range—Lower Miocene to Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria; Adelaide, South Australia.

Limopsis maccoyi Chapman

pl. 1, fig. 10

Limopsis belcheri Adams and Reeve. McCoy, 1875. Prod. Pal. Vict., 2, p. 25, pl. 19, fig. 8, 9.
Limopsis forskali Adams. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 122, 138, 146 (in part).
Limopsis maccoyi Chapman, 1911. Proc. Roy. Soc. Vict., 23, (n.s.), (2), p. 421-2, pl. 83, fig. 2; pl. 85, fig. 8.
Limopsis maccoyi Chapman. Chapman, Crespin, and Keble, 1928. Rec. Geol. Surv. Vict., 1, (2), p. 152.
Limopsis maccoyi Chapman. Crespin, 1943. Min. Res. Surv. Bull. 9, p. 93.

Diagnosis—Shell elongate-ovate, very oblique, radial ornament stronger than concentric, which is waving and fimbriate. Teeth short, curved, comparatively few.

Dimensions—Length 28, height 25, inflation (1 valve) 5·6, length of hinge 8·4 mm.

Type Locality—? Balcombe Bay, Victoria; Lower Miocene.

Location of Holotype—Naitonal Museum, Melbourne.

Material—Two valves, Abattoirs Bore. One valve, Tennant's Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Vict. — Adelaide, S. Aust.

Limopsis eucosmus Verco

pl. 1, fig. 11

Limopsis eucosmus Verco, 1907. Trans. Roy. Soc. S. Aust., 31, pl. 219, pl. 27, fig. 2.
Limopsis eucosmus Verco, Cotton and Godfrey, 1938. Moll. S. Aust., p. 55, text fig. 30.

Diagnosis—Small, orbicular, strongly sculptured with flat concentric ribs of varying width and numerous radial lirae increasing in number by intercalation. Concentrics scalloped by radials and a tubercle generally formed at intersection. Interspaces depressed and circular.

Dimensions—Length 7·5, height 8, inflation (both valves) 3·25 mm.

Type Locality—Off Cape Jaffa, 90 fathoms; Recent.

Location of Holotype—S. Aust. Mus., Reg. No. 13048.

Observations—One valve only belonging to this species, its first fossil record, was recovered from Weymouth's Bore. Its small size and strong sculpture distinguish it from other fossil species.

Material—Hypotype, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—Tasmania to Western Australia.

Limopsis (Limopsis) vixornata Verco

pl. 1, fig. 12

Limopsis vixornata Verco, 1907. Trans. Roy. Soc. S. Aust., 31, p. 219, pl. 27, fig. 1.
Limopsis vixornata Verco. Cotton and Godfrey, 1938. Moll., S. Aust., p. 54, fig. 36.

Diagnosis—A very small *Limopsis*, orbicularly oval, smooth but for concentric growth striae except in the posterior area where the concentric sculpture is crossed by radial striae. Hinge curved with eleven diverging teeth in a continuous series.

Dimensions—Length 6·4, height 5·7 mm.
Type Locality—Neptune Islands, 45 fathoms; Recent.
Location of Holotype—S. Aust. Mus., Reg. No. D13047.
Material—Figured hypotype and one other valve, Weymouth's Bore, 28 valves, Hindmarsh Bore.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—Beachport — St. Francis Island, S. Aust.

Genus Lissarca E. A. Smith, 1879

Lissarca Smith, 1879. Phil. Trans. Roy. Soc., **168**, p. 19, pl. 9, fig. 17.
(*Austrosarepta* Hedley, 1899. Proc. Linn. Soc. N.S.W., **24**, p. 430.)

Type species (monotypy) *Lissarca rubrofusca* E. A. Smith

Lissarca rubricata (Tate)

pl. 1, fig. 14

Limopsis rubricata Tate. 1887 a. Trans. Roy. Soc. S. Aust., **9**, p. 71.
Lissarca rubricata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Lissarca rubricata Tate. Cotton and Godfrey, 1938. Moll., S. Aust., p. 58, fig. 40.

Diagnosis—Obliquely oval, inflated, umbo prominent, sculpture of regular concentric striae, margins of valves crenulate.

Dimensions—Length 2·75, height 3, inflation (both valves) 1·75 mm.
Type Locality—32 fathoms, Backstairs Passage, S. Aust.; Recent.
Location of Holotype—S. Aust. Museum.
Material—Six valves, Hindmarsh Bore; 4 valves, Recent, Vict., B. M. Coll.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—Victoria, Tasmania, South Australia to 80 miles west of Eucla.

Lissarca rhomboidalis Verco

pl. 1, fig. 16

Lissarca rhomboidalis Verco, 1907. Trans. Roy. Soc. S. Aust., **31**, p. 221, pl. 27, fig. 7.

Diagnosis—Ovate, rhomboid, inequilateral, about twice as long behind the umbo as in front. Three or 4 marginal teeth at anterior, 4 at postdorsal and 3 or 4 obsolete teeth at ventral border.

Dimensions—Length 2·4, height 2 mm.
Type Locality—Macdonnell Bay and Guichen Bay, in shell sand; Recent.
Location of Holotype—No. 13050, S. Aust. Museum.
Material—Six valves, Hindmarsh Bore 450-487 feet, 3 valves Weymouth's Bore.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—Victoria, Tasmania, South Australia to MacDonnell Bay.

Family GLYCYMERIDAE

Genus Glycymeris da Costa, 1778

Glycymeris da Costa, 1778. Hist. Nat. Test. Brit., p. 168.
Glycymeris *Nicol*, 1945. Jour. Pal., **19**, (6), p. 616 (synonymy).

Type species (absolute tautonymy) *Arca glycymeris* Linné

Subgenus Tucetona Iredale, 1931

Tucetona Iredale, 1931. Rec. Aust. Mus., **18**, (4), p. 202.

Type species (o.d.) *Pectunculus flabellatus* Tenison Woods

Glycymeris (Tucetona) convexa (Tate)

Pectunculus convexus Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 138, pl. 11, fig. 7 a, b.
Pectunculus convexus var. Tate, 1890, id. 13, (2), p. 175.
Pectunculus convexus Tate and Dennant, 1893, id. 17, (1), p. 224.
Pectunculus convexus Tate. Harris, 1897. Cat. Tert. Moll. Brit Mus., 1, p. 342.
Glycimeris convexa Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 122, 138, 146.
Glycimeris maccoyi Johnston sp. Chapman and Gabriel, 1914. Proc. Roy. Soc. Vict., **26**, (n.s.), (2), p. 304, pl. 24, fig. 5 (*non* 1-4).
Glycimeris maccoyi Johnston sp. Chapman, 1916. Rec. Geol. Surv. Vict., **3**, (4), pl. 67, fig. 5 (*non* 1-4).
Glycimeris convexa Tate sp. Chapman and Singleton, 1925. Trans. Roy. Soc. Vict., **37**, (n.s.), (1), p. 38, pl. 2, fig. 16 a, 16 b, 17-20; pl. 4, fig. 12, 13.
Glycimeris convexa Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Glycymeris convexa Tate. Crespin, 1943. Min. Res. Surv. Bull. 9, p. 93.
Tucetona crama Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 660, pl. 20, fig. 1, 2.

Diagnosis—Solid, tumid, with about 24 rounded elevated radial ribs crossed by thick concentric waving laminae.

Dimensions—Length 31, height 33, inflation (both valves) 22 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Lower Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—This species is fairly common in the borings in the Adelaide district. Chapman and Singleton noted (1925, p. 38) in Adelaide examples a tendency to flattening of the ribs and development of concentric sculpture; on these features Cotton has raised the new species *crama*. Flattening of the ribs is not, however, a diagnostic or constant feature; all specimens from Weymouth's Bore show very little if any flattening, while some topotypes have flattened ribs; nor is the development of the concentric sculpture a uniform characteristic, either in the Weymouth's Bore specimens under present consideration or in Muddy Creek topotypes.

Increasing convexity with age is usual in the species. Juveniles are generally only slightly convex, while gerontic specimens can be extremely so. The feature is characteristic also of the type species *G. glycymeris* (Linné), as exemplified in a range of samples from the Red Crag of the English Pliocene in the collection of the Geological Survey of Great Britain.

The mode of preservation and the difference in habitat between Adelaide and Muddy Creek shells is here also taken into consideration in accepting Chapman and Singleton's determination of the species.

Material—Three topotypes, Muddy Creek, L4827, L6592, B.M. Coll.; seven valves Weymouth's Bore, numerous valves Hindmarsh Bore.

Stratigraphical Range—Lower Pliocene and Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria. — Adelaide, South Australia.

Subgenus TUCETILLA Iredale, 1939

Tucetilla Iredale, 1939. Barr. Reef Exped. Scient. Reps. Brit. Mus. Nat. Hist., **5**, (6), p. 300.

Type species (original designation) *Glycymeris capricornea* Hedley

Glycymeris (Tucetilla) tenuicostata (Reeve)

Pectunculus tenuicostatus Reeve, 1843, Proc. Zool. Soc., Lond., p. 80.
Pectunculus tenuicostatus Reeve, 1843, Conch. Icon., 1, pl. 6, fig. 35.
Pectunculus tenuicostatus Reeve, Lamy, 1912. Journ. de Conch., **59**, p. 103-6, pl. 3, fig. 3
Glycimeris tenuicostata Reeve, Gatliff and Gabriel, 1910 b. Proc. Roy. Soc. Vict., **23**, (n.s.) (1), p. 97.
Glycymeris tenuicostata Reeve sp. Chapman and Singleton, 1925. Proc. Roy. Soc. Vict., 37 (n.s.), (1), p. 36-7.
Glycymeris tenuicostata Reeve. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Glycymeris tenuicostata Reeve. Crespin, 1943. Min. Res. Surv. Bull. 9, p. 93.
Tucetilla rota Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 659.

Diagnosis—Rounded, moderately inflated, surface ornamented, with 40-45 riblets transversed by concentric growth threads which become beaded where they cross the radial costae.

Dimensions—Length 29·8, height 28·8, inflation (both valves) 19 mm.

Type Locality—"Australia"; Recent.

Location of Holotype—B.M. Coll., No. 1950-6-6-1-3.

Observations—The species *Tucetilla rota* is identical in shape and sculpture and the number of hinge teeth, the described diagnostic characters, with the holotype of *Glycymeris tenuicostata*. *G. tenuicostata* has been found consistenly from Balcombian to Werrikooian in southern Australia. It is recorded from Abattoirs Bore, and one example from Hindmarsh Bore, a young and worn shell length 8, height 7 mm., is undoubtedly *tenuicostata*. The species is represented in the British Museum by specimens other than the holotype having the following dimensions:

Length 32, height 32, inflation (both valves), 20 mm.
Length 29·8, height 27, inflation (both valves), 18 mm.
Length 19, height 17 mm., inflation not measured as specimen glued to tablet.

Material—Holotype: Three complete specimens, Brit. Mus. Coll.; 1 valve Hindmarsh Bore, 17 valves Abattoirs Bore.

Stratigraphical Range—Miocene to Recent.

Geographical Distribution—Queensland — South Australia.

Suborder **SCHIZODONTA**

Superfamily PTERIACEA

Family PTERIIDAE

Genus Pinctada Röding, 1798

Pinctada Röding ex Bolten 1798. Mus. Bolt. (2), p. 166.
Pinctada Thiele, 1935. Handb. Syst. Weicht., p. 803 (synonymy).

Type species (s.d. Iredale, 1915) *Mytilus margaritiferus* Linné

Pinctada crassicardia (Tate)

Meleagrina crassicardia Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 121-2, pl. 9, fig. 6, 10.
Margaritifera crassicardia Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 120, 138.
Pinctada crassicardia Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Pinctada crassicardia Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 660.

Diagnosis—Slightly oblique, hinge line long, straight, anterior ear of left valve short, tumid, acute, of right valve depressed; posterior wing, small pointed. Surface with distant growth striae.

Dimensions—Young example: Length of hinge 37, greatest length measured from umbo to post-ventral margin 37 mm. Average sized adult specimens measure 60 mm. in length.

Type Locality—Muddy Creek, Hamilton, Victoria; Lower Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Material—One large broken valve, Tennant's Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Family PINNIDAE

Genus Pinna Linné, 1758

Pinna Linné, 1758. Syst. Nat. ed. 10, p. 707.

Type species (s.d. Children, 1823) *Pinna rudis* Linné.

Subgenus Atrina Gray, 1847

Atrina Gray, 1847. Proc. Zool. Soc. Lond., p. 199.

Type species (monotypy) *Pinna vexillum* Born.

Pinna (Atrina) semicostata Tate

Pinna semicostata Tate, 1886 Trans. Roy. Soc. S. Aust., 8, p. 122, pl. 12, fig. 9.
Pinna semicostata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 138.
Atrina semicostata Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 655.

Dimensions—Length of dorsal margin 130, width 65, inflation (both valves) 43 mm.

Type Locality—Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. T997.

Observations—It is somewhat difficult to tell whether Tate's type is a *Pinna* s.str. or an *Atrina*, although the shape suggests *Atrina*. The writer followed Winkworth (1929) and Thiele (1935-) in the use of *Atrina* as a subgenus. It is separable from *Pinna* only on the absence of the internal medial angulation and the resultant division of the muscular impression.

Material—Holotype Tate Mus. Coll. T997.

Stratigraphical Range—South Australian Pliocene.

Geographical Distribution—Aldinga-Adelaide, South Australia.

Family OSTREIDAE

Genus Ostrea Linné, 1758

Ostrea Linné, 1758. Syst. Nat. ed. 10, p. 696.

Type species (s.d. Children, 1823) *Ostrea edulis* Linné.

Subgenus Lopha Röding, 1798

Lopha Röding ex Bolten, 1798. Mus. Bolt., 2, p. 168.

Type species (s.d. Dall, 1898) *Ostrea cristagalli* Gmelin

Lopha Bolten in Röding, 1798. Eames, 1951, Phil. Trans. Roy. Soc., ser. B. 627, 235, p. 362 (synonymy).

Ostrea (Lopha) hyotidoidea Tate

pl. 5, fig. 1

Ostrea hyotis Linné. Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 96, pl. 6, fig. 5.
Ostrea hyotis Linné. Dennant, 1889. Trans. Roy. Soc. S. Aust., 11, p. 49.
Ostrea hyotis Linné. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 299.
Ostrea hyotidoidea Tate, 1899. Trans. Roy. Soc. S. Aust., 12, p. 268.
Ostrea hyotidoidea Tate, Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 118.
Ostrea hyotidoidea Tate. Crespin, 1943, Min. Res. Surv. Bull. 9, p. 94.
Lopha hyotidoidea (Tate). Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 661.

Diagnosis—Irregular, with flattish radial ridges crossed by foliaceous scales, sometimes somewhat spinose.

Type Locality—River Murray Cliffs; Lower Miocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide. T880.

Description of Hypotype—Shell of moderate size, fairly solid, irregularly subquadrate, with several irregular flat obtuse radial folds. crossed by numerous irregular and waving foliaceous concentric scales which are sometimes slightly spinose. Margins of valves expanded, not plicated. Umbones depressed, resilifer broad, triangular. Left valve convex.

Dimensions—Length 65, height 60 mm.

Hypotype—B.M. Coll. No. 6581, Lower Beds, Muddy Creek, Victoria.

Observations—This long-ranging species is not uncommon in some borings in the Adelaide Basin. None of the specimens available are larger than about 65 mm. The species resembles the nepionic stages of *O. hyotis* Linné, but of the examples examined only the holotype shows a tendency to the sharply angular plications of the adult *hyotis* which are diagnostic of the subgenus *Lopha*.

Material—Holotype: Two valves Lower Beds, Muddy Creek, L6581. One specimen River Murray Cliffs. 48803 B.M. Coll.; numerous specimens Abattoirs Bore; 2 valves Hindmarsh Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria. — Adelaide, South Australia.

Subgenus Ostrea s.str.

Ostrea (Ostrea) arenicola Tate

Ostrea arenicola Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 97, pl. 10, fig. 6.
Ostrea arenicola Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vist., 1, (2), p. 138.
Ostrea angasi Sowerby, ibid., p. 145.
Ostrea arenicola Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 661.

Diagnosis—Solid, valves unequal, lower valve with depressed radial ribs and foliaceous lamellae; upper valve smaller and flattish, with imbricating lamellae.

Dimensions—Length 85, height 80, inflation (both valves) 25 mm.

Type Locality—Aldinga, South Australia. Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide. T921.

Observations—This oyster is common and numerous at the richly fossiliferous level in the Adelaide Basin. It is distinct from the *Ostrea startiana* of the River Murray Pliocene.

Material—One valve, Aldinga Bay, S. Aust. L10523, B.M. Coll. Numerous valves, Hindmarsh Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria. — Adelaide, South Australia.

Superfamily TRIGONIACEA

Family TRIGONIIDAE

Genus Neotrigonia Cossmann, 1912

Neotrigonia Cossmann, 1912. Ann. de Paleo., 7, (2), p. 11.

Type species (o.d.) *Trigonia pectinata* Lamarck

Neotrigonia trua Cotton

Neotrigonia acuticostata McCoy. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.
Neotrigonia trua Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 661-2, pl. 20, fig. 5-6.

Diagnosis—Shell trigonal, convex, with about 28 radiating ribs closely set with numerous lamellose tubercles.

Dimensions—Length 26, height 25 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—S. Aust. Museum. P. 8360.

Observations—*N. trua* is distinguishable from its nearest fossil ally *N. acuticostata* by its more trigonal shape, and by its greater convexity particularly in the umbonal region. There are 28 ribs generally in *N. trua* compared with 32 in *N. acuticostata*. *N. trua* would appear to be intermediate in form between the Cheltenhamian-Kalimnan *acuticostata* and the Recent South Australian *bednalli* which has 26 ribs.

Material—Holotype: Four topotypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Suborder **ISODONTA**

Superfamily PECTINACEA

Family PECTINIDAE

Genus Chlamys Röding, 1798

Chlamys Röding ex Bolten, 1798. Mus. Bolt., p. 161.

Type species (s.d. Hermannsen, 1847) *Pecten islandicus* Muller

Subgenus Chlamys s.str.

(*Mimachlamys* Iredale, 1929 c, ibid., p. 162.)
(*Mimachlaymys* Iredale, 1929 c, ibid., p. 162.)
(*Belchlamys* Iredale, 1929 c, ibid., p. 164.)

Chlamys (Chlamys) polyaktinos sp. nov.

pl. 4, fig. 16

Chlamys peroni Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 65, (1), p. 150.

Diagnosis—Suborbicular, with from about 24 increasing by intercalation to 48 narrow riblets carrying imbricating scales with shagreen sculpture in the interspaces.

Description of Holotype—(left valve). Shell small, rather thin, elongately suborbicular, slightly convex, sculptures with about 24 radial riblets, increasing by intercalation to 48 towards the ventral margin, of sub-equal strength, covered towards the ventral margin with imbricating scales. Interspaces finely shagreened. Auricles unequal, posterior auricle small, dorsal margin nearly horizontal, with about 10 fine rays with imbricating scales; anterior auricle larger, dorsal margin oblique, primary rays five with two secondary rays, crossed by fine growth lamellae, not scaly; byssal sinus moderately wide and deep.

Dimensions—Length 22, height 23·5, inflation (one valve), 3 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F15120.

Observations—Although it resembles it fairly closely, this species is not the Balcombian *C. peroni* (Tate), from which it is distinguished easily by the shagreen sculpture between the riblets. It is close to the Recent *C. aktinos* Petterd, from which it differs in the more numerous riblets and in shape, being less elongate. The posterior auricle is larger than in *aktinos*.

Material—Holotype and 16 paratypes, Abattoirs Bore (single valves). One valve Hindmarsh Bore, two fragments Tennant's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Chlamys (Chlamys) antiaustralis (Tate)

pl. 5, fig. 11

Pecten asperrimus var. Tate, 1882. Trans. Roy. Soc. S. Aust., 5, p. 44.
Pecten antiaustralis Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 106, pl. 9, fig. 7 a-c.
Pecten antiaustralis Tate. Harris 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 315-6.
Pecten antiaustralis Tate, 1899. Trans. Roy. Soc. S. Aust., 23, (2), p. 269.
Pecten antiaustralis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 138.
Chlamys asperrimus antiaustralis (Tate, 1886) Gatliff and Singleton 1930. Proc. Roy. Soc. Vict., 42, (n.s.), (2), p. 71-3, pl. 2, fig. 3; pl. 3, fig. 6, 7; pl. 4, fig. 10 a, b.
Chlamys antiaustralis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.
Mimachlamys antiaustralis Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 655.

Diagnosis—Suborbicular, with about 25 radiating ribs flanked by one or two smaller ribs on each, ribs convex, wider than in *C. asperrima* crossed by erect lamellae. Ears large, unequal; anterior ear of right valve with finer and more numerous radial ribs than in *asperrima*.

Dimensions—Length 58, height 58, inflation (both valves) 25 mm.

Type Locality—Aldinga Bay, South Australia; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—Examination of a series of specimens of *Chlamys islandica* (Muller), type species of *Chlamys*, of *C. asperrima* Lamarck, type species of *Mimachlamys* and of *P. opercularis*, type species of *Aequipecten* with which Thiele has synonymized *Mimachlamys*, sufficiently indicates that there is no subgeneric distinction between *Mimachlamys* and *Chlamys*.

The broad essential differences between *islandica* and *asperrima* are the somewhat unequal sculpture between the valves in *islandica*, and the marked serration of the ventral margin, with corresponding interlocking of the valves, in *asperrima*. The latter is, however, a variable feature and occurs to a modified degree in some specimens of *islandica*; it is a specific character dependent upon the degree of development of the primary ribs. In *asperrima* they are strongly

and sharply developed, in *islandica* the subsidiary ribs become larger and separate from the primary ribs. *Opercularis* is a round, broader shell with an undulating rather than a serrated margin.

Viewed in profile the ventral margins appear thus:

Ventral margin of *C. asperrima* - 

Ventral margin of *C. opercularis* - 

Ventral margin of *C. islandica* - - 

Other features considered by Iredale to be diagnostic of *Mimachlamys* are shared by all three species. The relative convexity of the valves is slightly variable, but the right valve is flatter than the left in all three.

The genus *Chlamys* s.str. is represented in the New Zealand Tertiary by 17 species (Marwick, 1928, p. 453) ranging from probably late Oligocene. The writer has not seen actual specimens of *C. chathamensis* Marwick (1928, p. 456, figs. 18, 19), but from the figures the species appears to be generically comparable wtih *asperrima*.

In the European Tertiary, the genus s.str. is represented by the *Chlamys varia* series (*C. varia, C. costai, C. justiana, C. jakloweciana, C. multistriata, C. islandica*, and *C. princeps* (Roger, 1939, p. 150-172, pl. 27, pl. 28, figs. 1-6) while *islandica* forms a connecting link between European and North American faunas.

The genus s.str. is represented in the post-Miocene of the Red Sea region by *C. squamosa, C. squamata, C. senatoria,* and *C. senatoria* var. *alexandri* (Cox, 1929, p. 190-1). Iredale (1939, p. 350) has placed *senatoria* in *Mimachlamys*, thus suggesting its synonymy with *Chlamys*.

Material—Numerous specimens, Hindmarsh Bore 450-487 feet, 2 valves Thebarton Bore, 11 valves and fragments Kooyonga Bore, 3 valves Adelaide, 42698; 2 valves Muddy Creek L 6579, 1 valve South Australia. 33789 B.M. Coll.

Stratigraphical Range—Pliocene.

Geographical Distribution—Western Victoria — Adelaide, South Australia.

Subgenus Equichlamys Iredale, 1929

Equichlamys **Iredale, 1929 c, Rec. Aust. Mus., 17, (4), p. 162.**

Type species (o.d.) *Pecten bifrons* Lamarck

Chlamys (Equichlamys) consobrina (Tate)

Pecten consobrinus Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 104, pl. 3, fig. 6.
Pecten consobrinus Tate, Tate and Dennant, 1893. id., **17**, (1), p. 224.
Pecten consobrinus Tate, Harris, 1897. Cat. Tert. Moll. Brit. Mus., p. 317.
Pecten consobrinus Tate, Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 138.
Pecten consobrinus Tate. N. H. Woods 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Equichlamys consobrinus Tate. Cotton 1947. Rec. S. Aust. Mus., **8**, (4), p. 654.

Diagnosis—Subinequivalve, with 8 radial folds and about 100 rigid, unequal riblets separated by minutely granular interspaces usually broader than the riblets.

Dimensions—Length 85 height 85 mm.

Type Locality—Aldinga Bay, South Australia; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide.

Material—Several fragments. Abattoirs Bore; several fragments, Tennant's Bore; 3 valves, Aldinga Bay, S. Aust. L 10533, L 9919 (topotypes) B.M. Coll.

Stratigraphical Range—South Australian Pliocene.

Geographical Distribution—Aldinga Bay — Adelaide, South Australia.

Subgenus Mesopeplum Iredale, 1929

Mesopeplum **Iredale, 1929 c. Rec. Aust. Mus., 17, (4), p. 163.**

Type species (o.d.) *Mesopeplum caroli* Iredale

Chlamys (Mesopeplum) incerta (T. Woods)

pl. 5, fig. 8, 9

Pecten coarctatus (?) Sturt, 1833. Two Exp. S. Aust., 2, p. 254, pl. 3, fig. 13.
Pecten coarctatus (?) Tenison Woods, 1862. Geol. Obs. S. Aust., p. 76.
Pecten incertus Tenison Woods, 1867. Proc. Phil. Soc. Adel. for 1865, (2), p. 1, pl. 1, fig. 1.
Pecten polymorphoides Zittel. Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 113, pl. 8, fig. 2.
Pecten polymorphoides Zittel. Tate and Dennant, 1893. id., 17, (1), p. 224.
Pecten polymorphoides Zittel. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 316.
Pecten polymorphoides Zittel. Dennant and Kitson 1903. Rec. Geol. Surv. Vict., 1, (2), p. 120.

Diagnosis—Inequivalve, left almost flat; valves with 5-7 broad folds with numerous bifurcating radiating ridges crossed by fine waving evenly spaced scales.

Dimensions—Length 44, height 40, inflation (both valves) 16 mm.

Type Locality—? River Murray Cliffs; ? Lower Miocene.

Location of Holotype—Not known at present.

Observations—This is a very variable species not previously recorded from the Adelaide Pliocene. Four right and two left valves were obtained from Weymouth's Bore. The fossil species resembles *C.* (*M.*) *caroli* Iredale from New South Wales more closely than the South Australian species *C.* (*M.*) *triggi*, Cotton and Godfrey. It is easily distinguished by its almost flat left valve, its 5-7 broad folds with their numerous ribs crossed by fine waving, evenly spaced scales.

Material—Six valves, Weymouth's Bore, 310-330 feet; 2 valves Bairnsdale L 341. 1 valve Muddy Creek L 4815 B.M. Coll.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide, South Australia.

Genus Lentipecten Marwick, 1928

Lentipecten Marwick, 1928. Trans. N.Z. Inst., 58, p. 455.

Type species (o.d.) *Pecten hochstetteri* Zittel

Lentipecten adelaidensis sp. nov.

pl. 1, fig. 13 a, b, c

Amusium hochstetteri Zittel. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.

Diagnosis—Thin and fragile, compressed, both valves smooth except for fine microscopic growth striae externally, apical angle 105° increasing to 120°. Ears subequal, anterior ear rayed, separated from valve by byssal notch and somewhat scaly; posterior ear broad, obtuse, smooth.

Description—Right valve, juvenile. Shell of moderate size, thin, fragile, smooth except for growth striae; equilateral except for ears, somewhat higher than long. Apical angle 105°. Dorsal margin slightly concave. Ears unequal, broken in the holotype, dorsal margin slightly oblique upwards, posterior ear smooth, anterior ear rayed with five weak rays, somewhat scaly or roughened from incremental ridges, with a byssal notch which does not form a radial ridge. Hinge margin narrow internally, intersected by resiliary pit. No ctenolium. Shell smooth internally, muscular impression sub-circular.

Dimensions—Length 11·3, height 12, inflation (one valve) 1 mm.

Paratypes—Hinge portion of right and left valves of adults, with ears nearly complete. The posterior ear of the right valve is of moderate length, slightly oblique on the dorsal edge, then rounded towards the posterior extremity with which it makes an angle of about 120°. Anterior ear somewhat roughened and scaly, with fairly deep byssal notch. Apical angle about 120°. Both ears of the left valve are smooth and apparently subequal. Estimated dimensions of the adult shell are length and height about 30 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype and Paratypes—Tate Mus. Coll., Univ. of Adelaide. F 15121.

Observations—The several species previously known as *Pecten hochstetteri* have had a very chequered history in both Australia and New Zealand. The history of the synonymy of the New Zealand Miocene *hochstetteri* has been clearly explained by Marwick (1928, p. 450), and in the same publication (p. 455) the genus *Lentipecten* is raised and described. *P. hochstetteri* Zittel, as delimited by Hutton being cited as type species. *Pseudamussium huttoni* Park is a synonym of *hochstetteri*, Park having overlooked Hutton's delimitation, and the ribbed form figured by Zittel (1864, pl. 11, fig. 5b) is *Serripecten polemicus* Marwick (1928, p. 451). *Lentipecten parki* Marwick from the New Zealand Eocene is closely related.

The Australian species, with exception of an early erroneous identification by Tenison Woods (1876, p. 2, pl. 1, fig. 5) as *Pecten pleuronectes* Gmelin, has, until recently, also been known as *P. hochstetteri*. Tate (1886, p. 114) compared Australian with New Zealand examples, redescribed the smooth species, and "with certainty" announced the identity of the Australian shells with the New Zealand *hochstetteri*. Marwick (1924b, p. 320) stated on erroneous grounds following Park and at that time rejecting Hutton and Tate, that the Australian species was not *hochstetteri* because it had two smooth valves, but that only careful comparison of a number of specimens would determine whether the Australian species were *P. huttoni* (*i.e., Lentipecten hochstetteri* in the correct sense) or not. This error has recently been revived by Crespin (1950, p. 151), who has evidently overlooked Marwick's later references to *hochstetteri* and has separated the Australian "Janjukian" shell from *hochstetteri* on the grounds that it has two smooth valves. There is little doubt that the Australian species *victoriensis* Crespin is distinct, although not for the reason given. Although *victoriensis* is identical in general appearance with *hochstetteri*, it has differently shaped ears; in the left valve of *hochstetteri* the ears have a straight horizontal dorsal margin; in *victoriensis* the margin is oblique to convex upwards and the margin is serrated as in the right valve of *L. parki* Marwick. The byssal notch in the anterior ear of the right valve seems stronger in *hochstetteri*. *L. hochstetteri* is equivalve, while in *victoriensis* the right valve is gently convex, the left almost flat.

The present species *adelaidensis*, also previously identified as *hochstetteri* and still known mostly from fragmentary material, is distinguishable from *victoriensis* by its lower apical angle (120° as against 130° in *victoriensis*), and by the ears. The ears are relatively large in *adelaidensis* and straight dorsally, while the discrepant ornament on the ears is diagnostic.

Material—Holotype, 2 paratypes (incomplete valves), 2 portions of paratypes, Abattoirs Bore, Adelaide. 1 fragment Tennant's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Genus Propeamussium de Gregorio, 1884

Propeamussium de Gregorio, 1884. Natural. Sicil, 3, p. 119.
(*Ctenamusium* Iredale, 1929b. Rec. Aust. Mus., 17, (4), p. 164.)

Type species (monotypy) *Pecten* (*Propeamussium*) *ceciliae* de Gregorio.

Propeamussium atkinsoni (Johnston)

Amusium Atkinsoni Johnston, 1880. Proc. Roy. Soc. Tas. for 1879, p. 41.
Pecten Zitteli Hutton. Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 115, pl. 7, fig. 3 a-c.
Amusium atkinsoni Johnston, 1888. Geol. Tas., pl. 31, fig. 15, 15 a.
Pecten zitteli Hutton. Tate and Dennant, 1893. Trans. Roy. Soc. S. Aust., 17, (1), p. 224.
Amussium zitteli Hutton. Tate and Dennant, 1895. Id., 19, (1), p. 112.
Amussium zitteli Hutton (sp.). Harris, 1897. Cat. Tert. Moll., Brit. Mus., 1, p. 324.
Amussium zitteli Hutton. Tate, 1899. Trans. Roy. Soc. S. Aust., 23, (2), p. 272.
Amussium zitteli Hutton. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 120.
Amussium atkinsoni Johnston. Marwick, 1924. Rep. Aust. Ass. Adv. Sci., 16, p. 318.
Propeamusium atkinsoni (Johnston). Chapman and Singleton, 1927. Proc. Roy. Soc. Vict., 39, (n.s.), p. 117.
Ctenamusium atkinsoni (Johnston). Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 660-1.

Diagnosis—Very small, equivalve, interior of valves concave, shining, with nine to eleven ribs which terminate truncately near the margin. Exterior of right valve with varying reticulate sculptures, left valve concentrically striated.

Dimensions—Length 4, height 4 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—? Hobart Museum.

Observations—This species was recorded for the first time from the Adelaide Pliocene at 330 feet in the Salisbury Bore by Cotton, 1947.

Material—20 valves, Muddy Creek, L 9876, B.M. Coll.

Stratigraphical Range—? Oligocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Hinnites Defrance, 1821

Hinnites Defrance, 1821. Dict. Sic. Nat., **21**, p. 169.

Type species (s.d. Blainville, 1825) *Hinnites cortesyi* Defrance = *Ostrea crispa* Brocchi

Hinnites corioensis McCoy

Hinnites corioensis McCoy, 1879. Prod. pal. Vict., **6**, p. 31, pl. 58, fig. 1-5 a.
Hinnites corioensis McCoy. Tate, 1886 a. Trans. Roy. Soc. S. Aust., **8**, p. 116.
Pecten deformis Tate 1887 b. id., **9**, pl. 18, fig. 4.
Hinnites corioensis McCoy. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 120.
Hinnites corioensis McCoy. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Hinnites corioensis McCoy. Crespin, 1950. Proc. Roy. Soc. Vict., **60**, p. 152, pl. 15, fig. 13.

Diagnosis—Young stage regular, ovate, with valves ornamented with intercalating ridges; adult stages irregular, upper or left valve flatter than right valve.

Dimensions—Length of large specimen 3·5 inches, height 3·5, inflation 1 to 2 inches.

Type Locality—Corio Bay, Victoria.

Location of Holotype—Vict. Mines Dept. Coll.

Material—Six fragments, Abattoirs Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Family SPONDYLIDAE

Genus Spondylus Linné, 1758

Spondylus Linné, 1758. Syst. Nat., **1**, ed. 10, p. 690.

Type species (s.d. Fleming, 1818) *Spondylus gaederopus* Linné

Spondylus spondyloides (Tate)

pl. 2, fig. 1

Pecten spondyloides Tate, 1882. Trans. Roy. Soc. S. Aust., **5**, p. 44.
Pecten spondyloides Tate, 1886. id., **8**, p. 112, pl. 4, fig. 6, *non* fig. 7.
Spondylus aldingensis Tate, 1896. Trans. Roy. Soc. S. Aust., **20**, (1), p. 121.
Spondylus arenicola Tate, 1896. Rep. Aust. Ass. Adv. Sci., **6**, p. 318 (nom. nul.).
Spondylus arenicola Tate, 1899. Trans. Roy. Soc. S. Aust., **23**, (2), p. 275.
Spondylus arenicola Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 138, 145.
Spondylus arenicola Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Spondylus spondyloides Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 655.

Diagnosis—Shell equilateral, inflated, with seven to nine primary ribs, between each pair of which there are two or three secondary and a variable number of tertiary ribs, all more or less spiny.

Dimensions—Length 44, height 44, inflation (both valves) 34 mm.

Type Locality—Aldinga Bay, South Australia; Pliocene.

Location of Syntypes—Tate Mus. Coll., Univ. of Adelaide. T956, T948 A-D.

Observations—Although Tate (1896, 1899) changed the specific name on account of its inappropriateness with the transfer to the genus *Spondylus*, the original *spondyloides*, in accordance with the International Rules of Zoological Nomenclature, must stand.

Material—One valve, Weymouth's Bore.
Stratigraphical Range—Dry Creek Sands.
Geographical Distribution—Adelaide, South Australia.

Family LIMIDAE

Genus Lima Cuvier, 1798

Lima Cuvier, 1798. Tabl. Elem. Hist. Nat. Anim., p. 421.

Type species (tautonymy) *Ostrea lima* Linné

Lima bassi Tenison Woods

Lima bassii Tenison Woods, 1877. Pap. Roy. Soc. Tas. for 1876, p. 112.
Lima bassii Tenison Woods. Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, p. 117, pl. 5, fig. 8; pl. 8, fig. 1.
Lima bassii Tenison Woods. Tate and Dennant, 1893. id. **17**, (1), p. 224.
Lima bassii Tenison Woods. Tate and Dennant, 1895. id. **19**, (1), p. 112.
Lima bassii Tenison Woods, Pritchard, 1896. Proc. Roy. Soc. Vict., **8**, (n.s.), p. 128.
Lima bassi Tenison Woods. Harris 1897. Cat. Tert. Moll. Brit. Mus., p. 130.
Lima bassi Tenison Woods. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 119, 145.
Austrolima bassi Tenison Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Lima bassi Tenison Woods. Crespin, 1943. Min. Res. Surv. Bull., **9**, p. 93.

Diagnosis—Obliquely subovate, rayed with about 25 imbricately squamose ribs.

Dimensions—Length 22, height 27 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—Hobart Museum, Tasmania.

Observations—*Lima bassi* belongs to *Lima* s.str. It is not here intended to investigate Recent species beyond their bearing on the present fauna, but the following comments are offered upon the genera into which South Australian members of the family have been placed (Cotton and Godfrey, 1938, pp. 104-109). *Austrolima* Iredale, 1929, is not separable from *Lima* in the generic sense (see also Thiele, 1935, p. 811), while *Mantellum* (type species, designated by Gray, *Ostrea lima* is a direct synonym of *Lima* (see also Winckworth 1930, p. 116).

Material—Eleven specimens, Lower Beds, Muddy Creek, L4820, L9840, B.M. Coll. 1 valve, Table Cape, writer's collection.

Stratigraphical Range—? Oligocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Superfamily ANOMIACEA

Family ANOMIIDAE

Genus Anomia Linné, 1758

Anomia Linné, 1758. Syst. Nat., **1**, ed. 10, p. 700.

Type species (s.d. Children, 1823) *Anomia ephippium* Linné

Anomia tatei Chapman and Singleton

pl. 4, fig. 11

Placunanomia ione Gray. Tate, 1890 a. Trans. Roy Soc. S. Aust., **13**, (2), p. 175.
Placunanomia ione Gray. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 145.
Anomia tatei Chapman and Singleton, in Chapman, Crespin, and Keble, 1928, id. **5**, (1), p. 99, pl. 11, fig. 76 a, b.
Monia ione Gray. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Anomia tatei Chapman and Singleton. Crespin, 1943. Min. Res. Surv. Bull., **9**, p. 92.
Monia tatei Chapman and Singleton. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 654.

Diagnosis—Surface unevenly convex with depressed radial threads narrower than the interspaces, crossing concentric undulose growth lines. Irregular ovate muscle scar beneath anterior end of chondrophore; large subcentral area with three muscle scars.

Dimensions—Probable length of shell when complete 60, height 50, inflation (one valve) 10 mm. Dimensions of muscular impressions, length 18, height 26 mm.
Type Locality—Grange Burn, near Hamilton, Victoria; Pliocene.
Location of Holotype—Geol. Surv. of Vict. Coll.
Observations—Cotton has listed this species with the statement "Recorded as *Placunanomia ione* Gray". It is not clear whether this is intended to apply only to Adelaide specimens or to those recorded from numerous localities and listed by Dennant and Kitson (1903, pp. 118, 138, 145).
Material—The figures hypotype and 34 other specimens, Abattoirs Bore. One valve, juvenile, Weymouth's Bore.
Stratigraphical Range—Pliocene.
Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Suborder **DYSODONTA**
Superfamily MYTILACEA
Family MYTILIDAE
Genus Brachidontes Swainson, 1840

Brachidontes Swainson, 1840. Treat. Malac., p. 384.
(*Brachyodontes* Agassiz, 1846. Nom. Zool. Ind. Univ., p. 51.)
Type species (o.d.) *Modiola sulcata* Lamarck

Brachidontes hirsutus (Lamarck)

pl. 4, fig. 15

Mytilus hirsutus Lamarck, 1819. Hist. Nat. Anim. s. Vert., 6, (1), p. 120.
Trichomya hirsuta Lamarck. N. H. Woods, 1931. Trans. Roy Soc. S. Aust., **55**, p. 150.
Diagnosis—Strongly curved, ornamented with fine, close, bifurcating riblets.
Dimensions—Height 60, width 26 mm.
Type Locality—"New Holland"; Recent.
Location of Holotype—Mus. Hist. Nat., Paris.
Material—Holotype; the figured hypotype and one other valve, Abattoirs Bore.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—New South Wales to Great Australian Bight.

Order **ANOMALODESMACEA**
Superfamily LATERNULACEA
Family MYOCHAMIDAE
Genus Myadora Gray, 1840

Myadora Gray, 1840. Ann. and Mag. Nat. Hist., 25, p. 306.
(*Myodora* Gray, 1840. Syn. Cont. Brit. Mus., ed. 42, p. 150.)
Type species (monotypy) *Pandora brevis* Sowerby

Myadora alea Cotton

Myadora ovata Reeve. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.
Myadora alea Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 665, pl. 20, fig. 20, 21, 22.
Diagnosis—Subovate, sculptured with about 36 concentric ribs in 11·5 mm., left valve smaller, less strongly sculptured.
Dimensions—Length 19, height 15 mm.
Type Locality—Salisbury Bore, 330 feet, South Australia; Pliocene.
Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. T1728.
Observations—This species is very close indeed to the Indo-Pacific *M. ovata* Reeve. The only diagnostic difference lies in the number of concentric ribs which are 30 in *ovata* and 36 in *alea* (30 according to Cotton's description). The posterior hinge is slightly more curved in *alea*. *M. ovata* is thinner and the external ribs tend to be more conspicuously shown on the interior of the shell.
Material—Two valves, Abattoirs Bore.
Stratigraphical Range—Dry Creek Sands.
Geographical Distribution—Salisbury and Abattoirs Bores, South Australia.

Myadora tenuilirata Tate

Myadora tenuilirata Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 174, pl. 17, fig. 9 a-b.
Myadora tenuilirata Tate. Tate and Dennant, 1893. Trans. Roy. Soc., S. Aust., 17, (1), p. 225.
Myadora tenuilirata Tate. Harris, 1897. Cat. Tert. Moll. Brit., Mus., (1), p. 390.
Myadora tenuilirata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 127, 139.
Myadora tenuilirata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.

Diagnosis—Elongate-oblong, left valve flat, ornamented with close-set fine, concentric ridges crossed by waving radial threads.

Dimensions—Length 16, height 10, inflation (both valves) 3 mm.

Type Locality—Lower Beds, Muddy Creek, Hamilton, Victoria; Miocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T1197.

Material—Three valves, topotypes. L9910, B.M. Coll.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Myadora corrugata Tate

pl. 1, fig. 17

Myadora corrugata Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 175, pl. 17, fig. 11 a-b.
Myadora corrugata Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 391.
Myadora corrugata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2) p. 139.
Myadora corrugata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.
Myadora corrugata Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 655.

Diagnosis—Triangularly ovate, with about 20 distant concentric ridges. Left valve flat.

Dimensions—Length 18, height 14·5, inflation (both valves) 4 mm.

Type Locality—Upper beds, Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide., T1192.

Material—Five valves, topotypes L4809, L9911, B.M. Coll., 2 whole valves, 2 portions, Weymouth's Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Section ADELOSIPHONIA

Family PANDORIDAE

Genus Cleidothaerus Stutchbury, 1830

Cleidothaerus Stutchbury, 1830. Zool. Journ., 5, (17), p. 97.

Type species (monotypy) *Aspergillum strangei* Adams

Humphreyia strangei (Adams)

Aspergillum strangei Adams, 1852. Proc. Zool. Soc. Lond., 20, p. 91, pl. 15, fig. 5.
Humphreyia strangei Adams. Tate, 1890. Trans. Roy. Soc. S. Aust. for 1889/90, 13, p. 174.
Humphreyia strangei Adams. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 147.
Humphreyia strangei Adams and Angas. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 150.

Diagnosis—Tube squarely rounded, obtusely keeled; valves squarely ovate.

Material—Holotype, B.M. Coll.; portion of sheath, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—New South Wales to Hardwicke Bay, South Australia.

Humphreyia incerta (Chenu)

Aspergillum incertum Chenu, 1842. Illust. Conchyl. 1, Aspergillum, p. 4, pl. 4, fig. 5, 5a, 6, 6a.

Diagnosis—Tube short, rounded, variously agglomerated, disc perforated by several apertures with tubes up to 4 mm. in length.

Type Locality—Swan River, Western Australia; Recent.

Location of Holotype—British Museum (Natural History).

Material—Holotype, B.M. Coll., Portions of disc, Abattoirs Bore, Adelaide.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—South Australia.

Family CUSPIDARIIDAE

Genus CUSPIDARIA Nardo, 1840

Cuspidaria Nardo, 1840. Atti. Ruin. Sci. Ital., 1, p. 175.
(*Neaera* Gray, 1839. 8th Rep. Brit. Ass. (Newcastle) non Robineau-Desvoidy, 1830.)

Type species (monotypy) *Tellina cuspidata* Olivi

Cuspidaria subrostrata Tate

Neaera subrostrata Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 177, pl. 15, fig. 2 a-b.
Cuspidaria subrostrata Tate (sp.) Harris, 1897. Cat. Tert. Moll. Brit. Mus., (1), p. 389.
Cuspidaria subrostrata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 127.
Cuspidaria subrostrata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150.

Diagnosis—Moderately convex, anterior dorsal margin slightly convex and sloping, posterior dorsal portion longer, less oblique, moderately concave. Ornamented with coarse concentric growth lines becoming lamellose at umbo and rostral insinuation.

Dimensions—Length 18, height 9, inflation (one valve) 3·5 mm.
Type Locality—Muddy Creek, Hamilton, Victoria; Lower Miocene.
Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.
Material—Three topotypes, Muddy Creek, L4810, L9845, B.M. Coll. 4 fragments Abattoirs Bore.
Stratigraphical Range—Lower Miocene to Pliocene.
Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Order TELEODESMACEA

Suborder DIOGENODONTA

Superfamily ASTARTACEA

Family CRASSATELLIDAE

Genus EUCRASSATELLA Iredale, 1924

Eucrassatella Iredale, 1924. Proc. Linn. Soc. N.S.W., 49, (3), 197, p. 203.

Type species (o.d.) *Crassatella kingicola* Lamarck

Eucrassatella camura (Pritchard)

pl. 5, fig. 4

Crassatella oblonga T. Woods. Tate, 1890. Trans. Roy. Soc. S. Aust., **13**, p. 175.
Crassatellites oblonga T. Woods. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 146.
Crassatellites camurus Pritchard, 1903. Proc. Roy. Soc. Vict., **15**, (2), p. 96, pl. 14, fig. 5, 9.
Crassatellites oblonga T. Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Eucrassatella camura (Pritchard). Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 662.

Diagnosis—Size medium, anterior very short, posterior attenuated, umbo strong, broad, medially depressed. Slightly to deeply concave posterior to beaks, ventral margin very slightly convex, medial portion usually straight.

Dimensions—Left valve length 54, height 41, inflation (one valve) 14 mm. Right valve length 55, height 37, inflation (one valve) 12 mm.

Type Locality—Grange Burn, Victoria; Pliocene.

Location of Syntypes—Melb. Univ. Geol. Dept., Nos. 1761-1766.

Material—Numerous valves, Hindmarsh Bore, 1 broken specimen Weymouth's Bore, 1 valve, Kooyonga Bore; 8 valves upper beds Muddy Creek, L4834, L6601, L9851, B.M. Coll.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Eucrassatella kingicoloides (Pritchard)

pl. 5, fig. 6

Crassatellites kingicoloides Pritchard 1903. Proc. Roy. Soc. Vict., **15**, (2), p. 94, pl. 13, fig. 1, 2, 3.
Eucrassatella kingicoloides (Pritchard). Singleton, 1945. Proc. Roy. Soc. Vict., **56**, (2), (n.s.), p. 257, 258.
Eucrassatella kingiculoides (Pritchard), Crespin, 1950, id. **60**, (n.s.), p. 153, pl. 14, fig. 6 (*lapsus calami* for *kingicoloides*).

Diagnosis—Broadly ovate, rather inflated near umbos but becoming depressed ventrally and posteriorly. Posterior dorsal margin deeply concave to a short straight posterior truncation. Ventral margin regularly convex. Umbos strong and tumid. Shell shallow internally.

Dimensions—Length 69, height 54 inflation (both valves) 36 mm.

Type Locality—Jemmy's Point, Kalimna, Victoria; Lower Pliocene.

Location of Holotype—Melb. Univ. Geol. Dept., No. 1756.

Observations—The two species of *Eucrassatella* listed above were originally classified as *E. oblonga.*

Cotton (1947, p. 662) has observed that the Adelaide species is not quite like *E. oblonga* nor quite like *E. camura* and figures a specimen approximating more closely to *camura.* Specimens from Hindmarsh Bore are *E. camura,* while those from Kooyonga Bore include both *camura* and *kingicoloides.* In the British Museum a tablet of specimens identified as *C. oblonga* from Muddy Creek, contains four examples each of what were later described as *kingicoloides* and *camura* respectively. Both species occur together at Jemmy's Point and in the Dry Creek Sands.

Material—One complete left valve, 3 portions, Kooyonga Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Cuna Hedley, 1902

Cuna Hedley, 1902. Mem. 4 Aust. Mus., p. 314.

Type species (o.d.) *Cuna concentrica* Hedley

Cuna polita (Tate)

pl. 1, fig. 15

Corditella polita Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 158, pl. 20, fig. 20, 21.
Corditella polita Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 124, 139.
Cuna polita Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Trigonal, slightly inequilateral, inner ventral margin crenulate.

Dimensions—Length 2·5, height 2·5 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; ? Miocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Material—Three valves, Hindmarsh Bore.

Stratigraphical Range—Miocene and Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Cuna aporema Cotton

Cuna aporema Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 662.

Diagnosis—Subtrigonal, higher than long, smooth except for growth striae, inner ventral margin without crenulations.

Dimensions—Length 4·25, height 5 mm.

Type Locality—Bore 41, 405 feet - 407 feet; Pliocene.

Location of Holotype—S. Aust. Mus., P8407.

Material—One specimen, Tennant's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide Plains.

Superfamily CARDITACEA
Family CARDITIDAE
Genus CARDITA Bruguière, 1792

Cardita Bruguière, 1792, Ency. Meth. Vers. (1), p. 401.
Type species (s.d. Fleming, 1818) *Cardita variegata* Bruguière.

Cardita compta (Tate)

pl. 2, fig. 2

Mytilicardia compta Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 149, pl. 12, fig. 2.
Mytilicardia compta Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 123, 138.
Cardita compta Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Cardita compta (Tate). Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 654.

Diagnosis—Posterior side narrow; 15 narrow scaly ribs consisting of 7 anterior ribs, 4 primary ribs, then 2 narrow posterior ribs followed by 2 compressed elevated ribs.

Dimensions—Length 29, greatest height 17, height at umbo 12 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Material—Four valves. Weymouth's Bore, 2 valves, Abattoirs Bore.

Stratigraphical Range—"Cheltenhamian" to Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Cardita subdeceptiva sp. nov.

pl. 4, fig. 14

Cardita preissi Menke. Tate. 1890 a. Trans. Roy. Soc. S. Aust., 13, p. 175.
Cardita preissi Menke. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 146.
Cardita preissi Menke. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Cardita compta Tate. Cotton 1947. Rec. S. Aust. Mus., 8, (4), p. 663.

Diagnosis—A fairly large *Cardita* rectangularly ovate, moderately convex, with 14 radial costae, 3 on the depressed posterior area, followed by 4 larger and approximately equal costae, then 7 costae gradually descending in size towards the anterior border. Interspaces wide, deep with steep sides; on the anterior portion the ribs are more or less nodulose, but the nodules fade out on the fifth rib from the posterior border. Ribs and interspaces crossed by frequent concentric growth lamellae.

Description of Holotype—Shell rectangularly ovate, solid, fairly thick, umbones slightly convex incurved, prosogyrate, situated at about one-sixteenth from the anterior border. Posterior margin elongate, posterior side somewhat expanded towards the ventral border but flattened in a long triangular area below the dorsal margin. Surface sculptured with 14 axial costae, of which there are 3 narrow costae in the depressed posterior area, followed by 4 larger approximately equal costae in the umbo-post-ventral area, then 7 gradually decreasing in size towards the anterior margin. Interspaces deep, wide, with steep sides; ribs more or less nodulose in the anterior portion, but nodules gradually becoming obsolete on about the fifth rib from the posterior border; ribs and interspaces crossed by frequent, crowded, concentric growth striae.

Inner margin of shell coarsely crenulate in conformity with the external ribs, hinge oblique to the ventral margin, damaged in the holotype.

Dimensions—Length 32, height 24, inflation (one valve) 12 mm.

Type Locality—Dry Creek Bore, Adelaide District; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F 15122.

Observations—This species very closely resembles *Cardita incrassata* Sowerby (= *C. preissi* Menke) with which it was formerly identified. However, *C. incrassata* has 16 radial costae wider than the interspaces which are narrower than those of *C. subdeceptiva*. *C. subdeceptiva* is broader than *C. incrassata*. It has fewer

costae than the Jemmy's Point species *C. kalimnae* (Pritchard) with 19 ribs of which the posterior are scaly.

Material—Holotype and five paratypes, Dry Creek Bore.

Stratigraphcal Range—Dry Creek Sands.

Geographical Distribution—Dry Creek, Croydon, and Abattoirs Bores, South Austriala.

Genus GLANS Megerle, 1811

Glans Megerle, 1811. Ges. Nat. Fr. Berlin. Mag. 5, (1), p. 68.

Type species (monotypy) *Glans trapezia* = *Venus trapezia* Linné

Glans spinulosa (Tate)

pl. 4, fig. 1

Cordita spinulosa Tate, 1886, Trans. Roy. Soc. S. Aust., 8, p. 153, pl. 2, fig. 3.
Cardita spinulosa Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 123, 139.
Venericardia spinulosa Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—A rotund-cordate *Glans* with high, tumid umbo; sculptured with 22 prominent, narrow, spinose ribs.

Dimensions—Length 33, height 31, length of anterior side 9, inflation (both valves) 36 mm.

Type Locality—Blue clays, Schnapper Point, Victoria.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—The hinge of *spinulosa* is that of *Glans*. The figured hypotype has the prominent laterally compressed costae of typical *spinulosa*, but the spinose character disappears ventrally and the costae become lamellose. This, according to Chapman and Crespin (1933, p. 68) is the principal diagnostic feature of their variety *dennanti* described below as a separate species. In Adelaide specimens at least the degree of platiness of the adult sculpture does not appear to be diagnostic of *spinulosa*, although in *dennanti* the ribs are always lamellose towards the margin. The two species are distinct in shape; *spinulosa* is more inflated, shorter, with more prominent and tumid umbo. The costae of *spinulosa* are very prominent and in the hypotype the interspaces, where they are not lamellose, are finely shagreened.

Material—Hypotype, Abattoirs Bore.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Glans dennanti (Chapman and Crespin)

pl. 2, fig. 6

Venericardia spinulosa (Tate) var. *dennanti* Chapman and Crespin 1933. Trans. Roy. Soc. Vict., 46, (1), p. 68, pl. 5, fig. 5, 6.
Venericardia spinulosa var. *dennanti* Chapman and Crespin, 1943. Min. Res. Surv. Bull., 9, p. 94.

Diagnoses—A *Glans*, rectangularly ovate, not inflated, with 23 radial costae bearing imbricating, scarcely-elevated spines at regular intervals. Towards the ventral margin the spines are less regularly disposed and the ribs become lamellose. Anterior margin short and gently rounded, post dorsal margin oblique then descending at an angle of 120° before curving to the ventral border. Posterior area flattened.

Dimensions—Length 24, height 19·5, inflation (one valve) 8 mm.

Type Locality—(Holotype) Old Bunga-road, east of No. 1 bore, Lakes Entrance, East Gippsland, Victoria.

Location of Holotype—Commonwealth Collection, Canberra, No. 53.

Locality of Hypotype—Weymouth's Bore, Adelaide, 310-330 feet.

Location of Hypotype—S. Aust. Mines Dept. Coll.

Observations—Originally described as a variety of *spinulosa* this is a distinct species from *spinulosa*, from which it differs in shape, inflation and sculpture. The dentition is that of *Glans* s.str. (Chavan, 1941, p. 99); the right hinge determinable from a broken specimen only having a weak A I, a weak 3a, a very strong 3b and a weak P II.

Should the species described by Tate and Basedow, 1902, as *Cardita dennanti* prove also to be a *Glans*, Chapman and Crespin's species will need a new name. Pending examination of the hinge of "*Cardita*" *dennanti* to locate the species more accurately the name of the present species is not altered.

Material—The hypotype and 3 left valves, portion of 1 right valve, Weymouth's Bore, Adelaide.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Pleuromeris Conrad, 1867

Pleuromeris Conrad, 1867a. Amer. Jour. Conch., 3, p. 12.

Type species (monotypy) *Cardita tridentata* Conrad.

Pleuromeris subpecten sp. nov.

pl. 2, fig. 3

Diagnosis—A small *Pleuromeris*, triangularly ovate, somewhat depressed, with 17 radial costae, equal to interspaces, bearing numerous elongated oval granules.

Description of Holotype—Left valve. Shell triangularly ovate, moderately depressed but evenly convex. Umbo slightly elevated acute, at about two-fifths from anterior border, moderately incurved and prosogyrate. Sculpture of 17 sharply defined radial costae with straight sides, about equal to the interspaces bearing numerous (about 5 per mm.) elongate-oval granules crossing the whole of the rib and projecting over the interspaces.

Hinge fairly narrow, with a long P II, a long and well-developed 4b, a small but high 2 and a small A II, the pit between 4b and 2 is small and narrowly triangular. Margin of valve crenulate, corresponding to external ribs.

Dimensions—Length 5·3, height 4·8, inflation (one valve) 1·6 mm.

Type Locality—Weymouth's Bore 310'-330'.

Location of Holotype—Tate Mus. Coll. F 15123.

Paratype—Right valve. Like the holotype, hinge with A I weak, 3b prominent and triangular, with a broad base, P II small.

Dimensions—Length 5·2, height 4·7, inflation (one valve) 1·4 mm.

Observations—*Pleuromeris subpecten* differs from *P. pecten* principally in the number of radial costae, *subpecten* having 17, *pecten* 22. The posterior slope in *subpecten* is not flattened and the shell is evenly convex throughout.

Material—Holotype, paratype, 5 topotypes, Weymouth's Bore. 18 specimens Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Weymouth's Bores, Adelaide.

Pleuromeris pecten (Tate)

Cardita pecten Tate, 1886. Trans. Roy. Soc. S. Aust., 8, p. 151, pl. 2, fig. 11.
Cardita pecten Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 139.
Venericardia pecten Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Venericardia pecten Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 654.

Diagnosis—A very small *Pleuromeris*, ovately triangular, depressed, with 22 compressed crenately granose ribs.

Original Description—Shell ovately triangular, transverse, rather depressed, regularly convex, except the flattened posterior slope; umbones small, acute,

antemedian, directed forwards; anterior margin of valves coarsely crenulated. Surface ornamented with 22 narrow, compressed, crenately-granose, radial ribs; interspaces flat, wider than the ribs.

Dimensions—Length 6·5, width 2, length from umbo to posterior angle 6·5, inflation (both valves) 3 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Material—Four valves Weymouth's Bore, 6 valves Hindmarsh Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Muddy Creek, Victoria — Adelaide, South Australia.

Pleuromeris trigonalis (Tate)

pl. 2, fig. 4

Cardita trigonalis Tate, 1886, Trans. Roy. Soc. S. Aust., **8**, p. 151, pl. 2, fig. 1.
Cardita trigonalis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 123, 139.
Venericardia trigonalis Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 655.

Diagnosis—Triangular, with 15 nodulose ribs.

Original Description—Shell triangular, moderately convex, umbones elevated, slightly oblique incurved, anterior posterior margin inclined, making with the slightly arched ventral margin a roundly acute angle; anterior side rounded; dorsally excavated. Surface ornamented with 15 crenately-nodulose, rounded, radiating ribs, the interspaces wider than the ribs with transverse thick lirae. Inner margin of valves coarsely crenulated.

Dimensions—Length 7, height 6·5 mm.

Type Locality—Blanche Point, Aldinga Bay; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Material—Four valves, Weymouth's Bore.

Stratigraphical Range—(?) Miocene; Pliocene of South Australia.

Geographical Distribution—(?) Gippsland, Victoria — Adelaide, South Australia

Genus CYCLOCARDIA Conrad, 1867

Cyclocardia Conrad, 1867 b. Amer. Journ. Conch., **3**, p. 191.

Type species (monotypy) *Cyclocardia borealis* Conrad

Subgenus SCALARICARDITA Sacco, 1899

Scalaricardita Sacco, 1899. Moll. Terr. Terz. Piem., **27**, p. 22.

Type species (monotypy) *Venericardia scalaris* Sowerby

Cyclocardia (Scalaricardita) subcompacta Chapman and Crespin

pl. 2, fig. 5, 8

Venericardia subcompacta Chapman and Crespin, 1928. Rec. Geol. Surv. Vict., **5**, (1), p. 102, pl. 5, fig. 21; pl. 11, fig. 80.
Venericardia subcompacta Chapman and Crespin, N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Venericardia subcompacta Chapman and Crespin. Crespin, 1943. Min. Res. Surv. Bull., **9**, p. 94.

Diagnosis—Subtrigonal, about as high as long, with 25 ovately beaded ribs. In the juvenile the radial sculpture is obsolete in the umbonal area and the concentric striae are produced anteriorly.

Dimensions—Length 2·5, height 3·2 mm.

Type Locality—Sorrento Bore, Mornington Peninsula, 605 ft.; Lower Pliocene.

Location of Holotype—Geol. Surv. Vict. Coll.

Material—Two figured hypotypes and 23 valves, Weymouth's Bore.

Stratigraphical Range—"Mitchellian" to Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Subgenus Arcturellina Chavan, 1951

Arcturellina Chavan, 1951, Compt. rend. Soc. Geol., France, 12, p. 210.
(*Arcturella* Chavan, 1941, Journ. de Conch., 84, (1), p. 100 *non* Sars, 1897.)
Type species (o.d.) *Venericardia asperula* Deshayes

Cyclocardia (Arcturellina) hindmarshensis sp. nov.

pl. 2, fig. 9

Diagnosis—A small *Arcturellina,* inflated, subtrigonal, with 19 radial costae carrying in the earlier stages oval-shaped imbricating tubercles, and in the latter stages irregular imbricating growth lamellae crossing ribs and interspaces without interuption.

Desciption of Holotype—Right valve. Shell fairly small, thick solid, subtrigonal, inflated. Umbo subcentral, high, incurved, prosogyrate, smooth at tip. Sculpture of 19 radial costae, equal to the interspaces, bearing in the early stages oval tubercles almost completely crossing the costae and in the later stages irregular imbricating growth lamellae crossing ribs and interspaces without interruption. Lunule broad, cordate, smooth except for growth striae. Escutcheon long and smooth, well marked. Hinge very heavy, strongly curved; 3a well developed, 3b strong; P III damaged in holotype, otherwise high. Inner margin heavy, ctenulate.

Dimensions—Length 8·5, height 9, inflation (one valve) 3·5 mm.

Paratype—Left valve, of which hinge is figured. Dentition P II (weak), 4b and 2 strong and projecting, A II fairly high.

Type Locality—Hindmarsh Bore 450-487 feet; Pliocene.

Location of Holotype and Paratype—Tate Mus. Coll., Univ. of Adelaide. F 15124.

Observations—The species *hindmarshensis* is close to *C.* (*A.*) *gippslandica* (Chapman and Crespin). It is, however, a smaller shell with a different sculpture. The ribs in *gippslandica* are beaded in the early and intermediate stages and lamellose in the later stages. At no stage has *gippslandica* the imbricating oval tubercles of *hindmarshensis.*

The subgenus *Arcturellina* to which *hindmarshensis* and *peridonea,* below, belong is represented in the European Eocene and Paleocene by the species (all of Deshayes *asperula* (Lutetian) *aizensis* (Montian and Cuisian), *prevosti* (Cuisian), *pulchra* (Cuisian), *ambiqua* (Lutetian) and *serrulata* (Lutetian). (Chavan 1941, p. 100). It is the Indo-Pacific subgenus of the otherwise typically American *Cyclocardia* and has apparently one survivor in "*Venericardia*" *bimaculata* Deshayes in Tasmania at the present day. (Chavan, 1949, p. 512).

Material—Holotype, paratype, and one topotype, Hindmarsh Bore, four specimens Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Weymouth's Bores, Adelaide.

Cyclocardia (Arcturellina) peridonea sp. nov.

pl. 2, fig. 7

Diagnosis—Triangularly ovate, not inflated, small, fairly solid, with 18 ribs bearing imbricating scales.

Description of Holotype—Left valve. Shell small, fairly solid, triangularly ovate. Umbo moderately inflated, directed anteriorly, incurved, fairly prominent. Dorsal margin straight, and sloping posteriorly, somewhat excavate and then more steeply sloping anteriorly. Both posterior and anterior margins rounded; anterior narrower and slightly directed dorsally while posterior margin is rounded with a direction towards the ventral margin. Ventral margin deeply curved. Surface sculptured with 18 radiating ribs, a little broader than interspaces, covered with narrow imbricating scales which tend to become platy towards the

ventral margin. Interspaces flat with fine and thin lamellae approximately corresponding to the scales on the ribs. Internal ventral margin coarsely crenulated. Hinge with teeth 4b and 2 widely divergent. Lunule impressed, smooth, elongate-cordate.

Dimensions—Length 8·5, height 8·0, inflation (one valve) 2·8 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F 15125.

Observations—*C. peridonea* is closest to *C. gippslandica;* it has fewer ribs, which are imbricate-scaly rather than tuberculate. The shell is smaller and less produced towards the umbo, which lacks the prominence of *gippslandica.*

Material—Holotype, paratype, 9 topotypes Hindmarsh Bore; 24 valves Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Family *CONDYLOCARDIIDAE*

Genus CONDYLOCARDIA Bernard, 1897

Condylocardia Bernard, 1897. Journ. de Conch., **44**, (3), p. 169.

Type species (o.d.) *Condylocardia sanctipauli* Bernard

Condylocardia tenuicostae Chapman and Gabriel

pl. 1, fig. 18, 19

Condylocardia tenuicostae Chapman and Gabriel, 1914. Proc. Roy. Soc. Vict., **26**, (n.s.), (2), 309.

Condylocardia tenuicostae Chapman and Gabriel. Chapman, 1916. Rec. Geol. Surv. Vict., **3**, (4), p. 388.

Condylocardia tenuicostae Chapman and Gabriel. Chapman, Crespin, and Keble. 1928. Rec. Geol. Surv. Vict., **5**, (1), p. 156.

Condylocardia tenuicostae Chapman and Gabriel. Crespin, 1943, Min. Res. Surv. Bull., **9**, p. 92.

Diagnosis—Broadly triangularly ovate, sculpture of about 36 narrow depressed riblets dying out in the umbonal area and crossed by concentric growth lines.

Dimensions—Holotype (left valve), length 2·15, height 1·77 mm.

Type Locality—Bore No. 10, 310-320 feet, Mallee Bores near Ouyen, north-west Victoria.

Location of Holotype—Geol. Surv. Vict. Coll.

Material—One valve, Hindmarsh Bore.

Stratigraphical Range—Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Superfamily ISOCARDIACEA

Family SPORTELLIDAE

Genus SPORTELLA Deshayes, 1858

Sportella Deshayes, 1858. Anim. s. Vert. Bassin de Paris, **1**, p. 593.

Type species (c.d.) *Psammobia dubia* Defrance

Sportella jubata Hedley

pl. 1, fig. 20

Sportella jubata Hedley, 1909. Proc. Linn. Soc. N.S.W., **34**, (3), p. 428, pl. 37, fig. 22-23.

Sportella jubata Hedley. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnoses—Subrhomboidal, longer than high, sculpture of fine, radiating threads increasing by intercalation. The lateral threads increase rapidly and diverge sharply at the umbo-post-ventral and antero-ventral angle and curve concavely towards the dorsal margin.

Dimensions—Length 8·5, height 6, inflation (one valve) 2 mm.

Type Locality—Hope Islands, North Queensland, 5-10 fathoms; Recent.

Location of Holotype—Australian Museum, Sydney.

Observations—The identification of this shell, described from North Queensland, is surprising. There are 14 specimens from the Hindmarsh Bore alone agreeing in all respects with the description of the type; dimensions of the average adult shell are the same as those of the type. One adult attained the following dimensions: Length 12, height 8·1, inflation (one valve) 2·5 mm.

Material—Fourteen valves Hindmarsh Bore, 2 valves Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—Adelaide District (Pliocene), North Queensland (Recent).

Superfamily CHAMACEA

Family CHAMIDAE

Genus CHAMA Linné, 1758

Chama Linné, 1758. Syst. Nat., 1, ed. 10, p. 691.

Type species (s.d. Fleming, 1818) *Chama lazarus* Linné

Chama lamellifera Tenison-Woods

Chama lamellifera Tenison-Woods. 1877. Proc. Roy. Soc. Tas. for 1876, p. 114.
Chama lamellifera Tenison-Woods. Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 149, pl. 14, fig. 5 a-b.
Chama lamellifera Tenison-Woods Tate and Dennant, 1893. Trans. Roy. Soc. S. Aust., **17**, (1), p. 224.
Chama lamellifera Tenison-Woods. Pritchard, 1897. Proc. Roy. Soc. Vict., **8**, (n.s.), p. 133.
Chama lamellifera Tenison-Woods. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 369.
Chama lamellifera T. Woods. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 125.
Chama lamellifera T. Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Surface of both valves sculptured with distant, thin, irregular, sometimes projecting lamellae. Lamellae finely radiately ridged and striated; interspaces concentrically striated.

Dimensions—Length 24, height 22, inflation (both valves) 18 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—Hobart Museum, Tasmania.

Material—Seven valves, Lower Beds, Muddy Creek, Victoria. B.M. Coll., 3 valves, Abattoirs Bore (? from pre-Pliocene strata).

Stratigraphical Range—Not definitely established.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Superfamily LUCINACEA

Family LUCINIDAE

Genus MYRTEA Turton, 1822

Myrtea Turton, 1822. Conch. Insul. Brit., p. 15, 133.

Type species (monotypy) *Venus spinifera* Montagu

Myrtea fabuloides (Tate)

pl. 2, fig. 16

Lucina fabuloides Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, pl. 12, fig. 5.
Lucina fabuloides Tate, 1887 b. *id*, **9**, p. 145.
Lucina fabuloides Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 126, 139, 147.
Lucina fabuloides Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Epicodakia fabuloides Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 655.

Diagnosis—Oblong-ovate, compressed, surface with about 16 erect thin lamellae. Hinge with two small cardinal teeth in right valve, one cardinal and two distant laterals in left valve.

Dimensions—Length 9, height 7 mm.

Type Locality—Oyster beds, Blanche Point, Aldinga Bay; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—*M. fabuloides* is widely distributed in small numbers in the Dry Creek Sands. It is recorded in all bores under present consideration, from the Dry Creek Bore, and by Cotton (1947, p. 655).

Material—Three valves Weymouth's Bore, 3 valves Abattoirs Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Murray River–Adelaide, South Australia.

Genus MONITILORA Iredale, 1930

Monitilora Iredale, 1930, Rec. Aust. Mus., 17, (9), p. 390.

Type species (o.d.) *Lucina ramsayi* Smith

Subgenus MONITILORA s.str.

Monitilora (Monitilora) idonea sp. nov.

pl. 3, fig. 1, 2

Diagnosis—Rotund, subequilateral, umbo subcentral, prominent, incurved; sculpture of fine, sharp, concentric lirae, narrower than interspaces between which are numerous fine radials weaker than concentrics, not always regular and completely crossing the interspaces but sometimes merely producing the appearance of fine pittings. Concentrics generally, but not always, show impression of junction with radials and are then minutely scalloped. Lunule rather small, elongate-cordate, smooth, deep.

Description of Holotype—Left valve. Shell thin, of moderate size for the genus, convex, subcircular, subequilateral. Posterior dorsal margin gently sloping, anterior dorsal margin slightly excavate near the umbo and gently oblique towards the anterior border which is, like the posterior border, slightly truncate. Ventral margin broadly rounded. Umbo subcentral, prominent, slightly inflated and incurved, directed anteriorly. Lunule fairly small, elongate-cordate, smooth, deep. Sculpture of numerous, fine, sharp concentric lirae, 5 per mm., narrower than interspaces between which are numerous fine radials weaker than the concentrics, not always regular and completely crossing the interspaces, but short and irregular, giving the appearance of fine pittings. Junction of radials and concentrics nearly always indicated by scalloping of the concentrics. Hinge teeth obsolete in left valve. Ligament groove long, internal. Internal ventral margin smooth, area inside pallial line chalky and inclined to be pitted. Anterior adductor scar elongate-oval, pointed dorsally, posterior scar shorter and broader and pointed at both ends. Pallial line simple.

Dimensions—Length 12, height 11, inflation (one valve) 3 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F 15126.

Observations—Compared with the type species *M. ramsayi* (Smith) *idonea* is a smaller shell, with more valid radials and sharper concentrics. The shell is more evenly rounded posteriorly. The umbo is more prominent and more incurved; the lunule is deeper. Internally, the area inside the pallial line is not so punctate as in *ramsayi*. The species is also very similar to *M. elegans* (Defrance) from the European Eocene, from which it differs principally in shape and rotundity. There is no doubt that all three species are congeneric.

Material—Holotype and 5 topotypes, left valves, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Subgenus PROPHETILORA Iredale, 1930

Prophetilora Iredale, 1930. Mem. Qld. Mus., 10, (1), p. 75.

Type species (monotypy) *Prophetilora arizela* Iredale

Monitilora (Prophetilora) chavani sp. nov.

pl. 2, fig. 13

Lucina leucomorpha Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 15 (non Tate).

Diagnosis—Quadrately orbicular, posterior margin slightly truncated, surface sculptured with numerous regular concentric lirae, narrower than interspaces, slightly retroflexed anteriorly. Interspaces with inconspicuous and somewhat irregular radial grooves. Hinge edentulous.

Description of Holotype (right valve)—Shell of medium size, quadrately orbicular, anteriorly excavate beneath the umbo and rounded; slightly truncated posteriorly. Umbo small, only slightly incurved, strongly directed anteriorly, approximate. Lunule short, cordate, deeply impressed and transgressing the hinge area. Hinge edentulous, ligament long, internal, deeply impressed; anterior muscle scar very long, within the pallial line and parallel to it for two-thirds its length; posterior scar elongate ovate, pointed at each end. Pallial line entire. Interior inside pallial line chalky, roughened. Pallial line entire. Internal ventral margin smooth. Shell externally sculptured with fine regular concentric lirae 3 per mm., slightly retroflexed anteriorly, narrower than interspaces. Interspaces with fine conspicuous and somewhat irregular radials, visible only under magnification; two straight umbo-posterior radial grooves marking the posterior wing and two rather deeper grooves, concave dorsally, on the anterior wing.

Dimensions—Length 18·5, height 17, inflation (one valve) 4 mm.

Paratype (left valve)—Hinge edentulous, lunule very deep, ligament deep.

Dimensions—Length 13, height 11·5, inflation (one valve) 2·5 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F 15127.

Observations—The nearest relative to this species is the Recent *M.* (*P.*) *arizela* Iredale, from North Queensland. The fossil species is more regularly and strongly sculptured and the posterior radial grooves are less strong.

Material—Holotype, 2 paratypes.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Genus EOMILTHA Cossmann, 1912

Eomiltha Cossmann, 1912. Act. Soc. Linn., Bordeaux, 66, p. 269.

Type species (o.d.) *Lucina contorta* Defrance

Subgenus GIBBOLUCINA Cossmann, 1904

Gibbolucina Cossmann, 1904. Bull. Soc. Geol. Normandie, 23, p. 13.

Type species (monotypy) *Lucina callosa* Lamarck

Eomiltha (Gibbolucina) salebrosa (N. H. Woods)

pl. 6, fig. 3

Codakia salebrosa N. H. Woods, 1931. Trans. Roy. Soc S. Aust., 55, p. 149, pl. 8, fig. 4, 5.
Epicodakia salebrosa (Hooper Woods), Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 663.

Diagnosis—Thick, rude, irregular, sculptured with concentric striae and irregular growth lines becoming lamellose near ventral margin. Hinge teeth obsolete.

Dimensions—Length 27·5, height 26·7 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—This species was described from the Abattoirs Bore, and although Cotton has since recorded it, the writer has not seen it in any other boring. It is a typical *Gibbolucina*, very like the species *G. ellipsoidalis* from the European Eocene. The appearance of the European genus in the Australian Pliocene is worthy of some note, but there appears to be considerable similarity between the lucinid fauna of the European Eocene and of the Adelaide Pliocene.

Material—Three topotypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Eomiltha (Gibbolucina) confirmans sp. nov.

pl. 2, fig. 11.

Diagnosis—A small *Gibbolucina*, moderately thick and rough, subglobose with prominent elevated umbo. Sculpture of concentric ridges of irregular shape with prominent growth folds near the ventral margin. Hinge rather coarse with a central pit bordered by the posterior cardinal 4 overhanging the weaker median 2b in the left valve. Right valve with an oblique 3b and an anterior lateral A I. Posterior border rounded, anterior somewhat effuse.

Description of Holotype (right valve)—Shell small, subglobose, moderately thick and rough. Umbo prominent, elevated, well-incurved and prosogyrate. Sculpture of concentric ridges about 6 per mm. somewhat irregular and crowding near the ventral margin. Growth folds conspicuous. Lunule small and cordate, deep, smooth, bounded by a ridge. Hinge fairly thick with the lunule transgressing the area and attaching to the oblique 3b above, leaving a triangular pit beneath. Anterior lateral A I well developed and conspicuous. Interior of valve striate and secondarily thickened. Anterior adductor of moderate length, considerably narrower in the ventral portion which is inside and separated from the pallial line. Posterior adductor elongate-ovate, pointed dorsally. Valve much more convex inside the pallial line and flattening out between the pallial line and the ventral border. Margin plain.

Dimensions—Length 9 (estimated unbroken 10), height 9, inflation (one valve) 3 mm.

Paratype—Juvenile, left valve, somewhat doubtfully belonging to the same species. Shell with anterior margin complete, expanded towards the dorsal margin, posterior margin slightly broken in this specimen also. Lunule deep, transgressing the hinge. Hinge with a small median cardinal 2b and a longer posterior cardinal 4 overhanging the 2b.

Dimensions—Length 8, height 7, inflation (one valve) 2 mm.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll. F 15128.

Observations—The presence of the second species of *Gibbolucina* in the fauna confirms the existence of the genus in the Australian Pliocene. It is a small *Gibbolucina*, nearest to the type species *callosa* and considerably less rude than *salebrosa*.

Material—Holotype and paratype, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Genus Linga de Gregorio, 1885

Linga de Gregorio, 1885. Bull. Soc. Malac. Ital., 10, p. 217.

Type species (s.d. Sacco, 1901) *Lucina columbella* Lamarck

Subgenus Bellucina Dall, 1901

Bellucina Dall, 1901. Proc. U.S. Nat. Mus., 23, p. 806.

Type species (o.d.) *Parvilucina eucosmia* Dall.

Linga (Bellucina) nuciformis (Tate)

pl. 2, fig. 14, 15

Lucina nuciformis Tate, 1886. Trans. Roy. Soc. S. Aust., 8, pl. 12, fig. 10.
Lucina nuciformis Tate, 1887. *id.* 9, p. 144.
Lucina nuciformis Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 385.
Lucina nuciformis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv., Vict., 1, (2), p. 139, 147.
Lucina nuciformis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Epicodakia nuciformis. Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 655.

Diagnosis—Shell small, globose, very thick, sculptured with subacute concentric ridges, about 2 per mm., the interspaces sometimes crossed with fine radials. Margins of valves strongly crenulated.

Dimensions—Length 9, height 9, section (both valves) 8 mm.

Type Locality—Oyster beds, Blanche Point, Aldinga Bay; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide.

Observations—Together with *Callucina balcombica*, *nuciformis* is the most commonly occurring lucinid in the Dry Creek Sands. It is a typical *Bellucina* comparable with the European Eocene *B. ligata* and with the Indo-Pacific type species *eucosmia* Dall. It is not an *Epicodakia*.

Material—Five valves, Weymouth's Bore, 5 valves Abattoirs Bore, 5 valves Hindmarsh Bore. Six topotypes L 9871. B.M. Coll.

Stratigraphical Range—South Australian Pliocene.

Geographical Distribution—Aldinga and Adelaide, South Australia.

Genus Callucina Dall, 1901

Callucina Dall, 1901. Proc. U.S. Nat. Mus., 23, p. 806.

Type species (o.d.) *Lucina radians* Conrad

Callucina (s.l.) balcombica (Cossman)

pl. 2, fig. 10

Lucina affinis Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9., p. 143, pl. 18, fig. 11.
Lucina affinis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 126, 139, 147.
Lucina balcombica (nom. mut. for *affinis* preoccupied) Cossmann, 1912. Rev. Crit. de Paleozool., 16, (3), p. 214.
Lucina balcombica Cossmann. Finlay, 1927. Trans. N.Z. Inst., 57, p. 529.
Lucina affinis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Epicodakia affinis Tate. Cotton, 1947. Rec. S. Aust., Mus., 8, (4), p. 654.

Diagnosis—Roundly subquadrate, sculptured with numerous fine, concentric threads about 8 per mm. Internal margin finely crenulate.

Dimensions—Length 6, height 5·5, inflation (left valve) 1·75 mm.

Type Locality—Oyster beds, N.W. Bend, River Murray; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide.

Observations—This species is of frequent occurrence in the borings. It is not an *Epicodakia*. The left valve has two divergent cardinal teeth, one (4b) generally close to the umbo and coincident with the nymph, the other (2) lower and sometimes sunken, laterals (P II and A II) both weak or absent. Right valve with a relatively strong high cardinal tooth (3 b) channelled medially. Laterals P I and A I weak to absent. The marginal crenulations are very fine and narrow, on the margin only and scarcely extending on to the internal layer of the shell. External sculpture is finely concentric, with no suggestion of radials.

The species belongs to a group of *Callucina* typified by "*Lucina*" *albella* of the French Eocene.

Material—Ten valves Weymouth's Bore, 9 valves Hindmarsh Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Gonimyrtea Marwick, 1929

Gonimyrtea Marwick 1929. Trans. N.Z. Inst., 59, p. 912.

Type species (o.d.) *Loripes concinna* Hutton

Gonimyrtea salisburyensis sp. nov.

pl. 2, fig. 12

Loripes icterica Reeve. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Shell small, thin, quadrately orbicular, truncate posteriorly, rounded anteriorly. Sculpture of fine concentric striae and microscopic irregular radials. Obsolete curved radial sulci visible in oblique light.

Description of Holotype (left valve)—Shell small, thin, quadrately orbicular; posterior margin truncate, almost vertical, anterior margin roundly produced. Post-dorsal margin straight, sloping; anterior-dorsal margin excavate near umbo,

then almost horizontal. Ventral margin roundly curving; interior obscurely crenate. Sculpture of very fine and irregular growth striae between which are very faint and fine crowded concentric threads visible only under magnification crossed by microscopic somewhat irregular and bifurcating radial markings. In addition to the microscopic ornament, under strong light curved radii which are concave anteriorly are visible. From the umbo to the postventral margin there is a shallow and obsolete radial sulcus. Interior of valve striate. Hinge somewhat narrow, with two diverging cardinal teeth with a triangular pit between, laterals absent. Ligament pit long and narrow, sunken. Lunule elongate-cordate, only slightly impressed. Adductor impressions well marked, anterior impression elongate, inside pallial line.

Dimensions—Length 12·5, height 12, inflation (one valve) 3 mm.

Paratype (right valve)—Hinge with one triangular cardinal tooth and one somewhat indefinite anterior lateral.

Dimensions (specimen broken)—Length 9, height 8, inflation 2 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F 15129.

Observations—This is the shell formerly recorded as *Loripes icterica* (Reeve). Whether the Recent shell also known as *Loripes icterica* and *Wallucina icterica* (Cotton and Godfrey, 1938, p. 203) is conspecific is at present left open to doubt until an opportunity is given to examine Recent South Australian specimens. Examination of the holotype of *Lucina icterica* Reeve in the British Museum Collection has revealed that this shell is not a Lucinid but a *Semele*, described from three Museum Cuming shells from an unknown locality. It has been identified in the British Museum Collection with *Semele proficua* Pulteney. It is not here intended to investigate the correct identity of Reeve's *icterica*, which is certainly not the shell hitherto known under that name from Australia. The present species is somewhat difficult to place. It is not a *Wallucina* as the hinge bears little resemblance to that of *Loripes* (*Wallucina*) *jacksoniensis*, type species of *Wallucina*; in relation to the width of the hinge the teeth of *salisburyensis* are small; in *jacksoniensis* the hinge is very narrow, scarcely wider than the dorsal margin, while the cardinal teeth are relatively long and prominent; the ligament of *salisburyensis* differs completely from that of *jacksoniensis* which is entirely internal and transgresses the hinge area. The hinge and general characters approximate most closely to those of *Callucina balcombica*; both species have two cardinal teeth in the right valve, although in *salisburyensis* there is a tendency to obsolescence of the posterior of the two.

Material—Holotype and Paratype, Abattoirs Bore; 3 valves Hindmarsh Bore, 1 valve Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands; (?) Recent.

Geographical Distribution—Fossil, Adelaide, (?) Recent Victoria — West Australia.

Gonimyrtea crassior sp. nov.

pl. 3, fig. 3, 4

Diagnosis—A fairly thick *Gonimyrtea* with a high conspicuous umbo. Lunule fairly deep, moderately elongate-cordate, smooth but for growth lines. Sculpture less regular than in the species *notabilior* and *validior* and growth folds conspicuous. Sculpture of concentric lirae 5 per mm. narrower than the interspaces which are not so flat as in the species *notabilior* or *validior*.

Description of Holotype (right valve)—Shell of moderate size, fairly thick, umbo subcentral, high, pointed, conspicuous. Posterior dorsal margin gently curving, anterior dorsal margin excavate beneath the umbo, then almost straight. Posterior margin truncate, anterior margin oblique for a short distance, then roundly curved. Growth folds conspicuous and fairly deep. Sculpture of con-

centric lirae 5 per mm., narrower than interspaces which are only sometimes flat; lirae tend to be truncated by an umbo-anterior-ventral sulcus, and not all extend over the whole of the shell. Lunule fairly deep, moderately elongate-cordate, smooth but for growth striae. Interior of valve radially striate. Inner margin raised; pallial line impressed; anterior adductor impression fairly long and moderately broad; posterior adductor subovate, very pointed dorsally. Hinge with a single cardinal (3b) and a well developed anterior lateral (A I).

Dimensions—Length 9·5, height 9, inflation (one valve) 3 mm.

Paratype (left valve)—Hinge with a deep subumbonal pit for the reception of 3b in the right valve and two diverging cardinals 2 and 4b, 2 bordering the lunule. Ligament pit long and deep.

Dimensions—Length 8, height 7, inflation (one valve) 2·5 mm.

Type Locality—Weymouth's Bore, Adelaide, 310-330 feet; Pliocene.

Location of Holotype and Paratype—Tate Mus. Coll., Univ. of Adelaide. F 15130.

Observations—The height of the umbo, coarser sculpture, and greater thickness of the shell are distinguishing features of the species.

Material—Holotype, 2 paratypes, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's Bore, Adelaide.

Gonimyrtea validior sp. nov.

pl. 3, fig. 5, 6

Diagnosis—A *Gonimyrtea* of moderate thickness with a relatively low umbo, sculptured with well-spaced concentric lirae about 4 per mm. with fairly broad, flat interspaces about three times as wide as the lirae. Inner margin raised. Lunule shallow, inconspicuous, not margined.

Description of Holotype (left valve)—Shell small, moderately thick, suborbicular, moderately inflated. Umbo subcentral, moderately inflated, gently incurved, prosogyrate. Shell depressed and somewhat broadly sulcate in the anterior dorsal area. Dorsal margin nearly straight, posterior margin gently curved, anterior margin descending obliquely at an angle of about 120° to the dorsal margin, then roundly curving to the ventral margin. Ventral margin strongly curved. Sculpture of fine concentric lirae about 4 per mm., broadly spaced, narrow, and where they are not broken inclined to be recurved towards the umbo; interspaces nearly three times as wide as lirae, broad flat, showing faint growth threads. Lunule shallow, inconspicuous, not margined. Hinge nearly straight with two small sharp diverging cardinals (2 and 4b) curved convex to the posterior; laterals absent except for an obsolete pit for the reception of the anterior lateral of the right valve. Anterior adductor impression of moderate length and fairly broad, posterior adductor ovate, pointed dorsally. Pallial line punctate at broad intervals. Interior ventral margin raised.

Dimensions—Length 9, height 8, inflation (one valve) 2 mm.

Paratype (right valve)—Hinge with an oblique posterior cardinal (3b) and a weak anterior lateral (A I).

Dimensions—Length 8, height 7, inflation (one valve) 1·5 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Location of Holotype and Paratype— Tate Mus. Coll., Univ. of Adelaide. F 15131.

Observations—The relatively more widely spaced concentric sculpture, together with the rather low umbo, serve to distinguish this species from the other small Gonimyrtea species described. It has the characteristic raised inner margin of *Gonimyrtea* and typical hinge, with laterals somewhat obsolete.

Material—Holotype and paratype, Hindmarsh Bore. Ten paratypes Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's and Hindmarsh Bores, Adelaide.

Gonimyrtea notabilior sp. nov.

pl. 3, fig. 7, 8

Diagnosis—A rather thin *Gonimyrtea* with a moderately high umbo very smooth at the tip, well incurved and prosogyrate, sculptured with fine regular concentric lirae about 5 per mm., nearly half of which extend over the central part ot the shell only, separated by interspaces about twice as wide as the lirae. Inner margin only slightly raised. Lunule elongate-cordate, bounded by a ridge crossed by growth striae.

Description of Holotype (right valve)—Shell of moderate size, fairly thin, suborbicular, longer than high, inflated. Umbo sub-central, fairly high, smooth at tip, well incurved, prosogyrate. Sculpture of fine regular smooth concentric lirae, about 5 per mm., almost every other one of which extends over the central part of the shell only, so that there are fewer lirae on the posterior and anterior portions. Interspaces smooth and flat, about twice as wide as the lirae. There is a sulcus extending from the umbo to both the post-ventral and anterior ventral borders. Lunule elongate-cordate, bounded by a ridge, crossed by concentric growth striae. Interior of valve radially striate particularly inside the pallial line. Margin only slightly raised; pallial line marked but not conspicuous in the holotype; interior adductor of moderate width, posterior adductor ovate. Hinge with a bifid cardinal (3b) and a conspicuous anterior lateral (A I), ligament pit long and deep.

Dimensions—Length 11, height 10 inflation (one valve) 3 mm.

Paratype (left valve)—Hinge with two diverging cardinals (2 and 4b). Laterals absent.

Dimensions—Length 10, height 9, inflation (one valve) 3 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Localtion of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15132.

Observations—This species is separable from the preceding *G. validior* by its conspicuous lunule, relatively close concentric sculpture and less raised inner margin. The umbo is higher than in *validior*.

Material—Holotype and paratype and six topotypes, Hindmarsh Bore; four valves Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Genus Miltha H. & A. Adams, 1857

Miltha H. and Adams, 1857. Gen. Rec. Moll., 2, p. 468

Milthoidea Marwick, 1931. N.Z. Geol. Surv. Pal. Bull., 13, p. 70.

Type species (monotypy) *Tellina childreni* Gray

Miltha hora (Cotton)

Dosinia grandis N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 148, pl. 7, fig. 5, 6. (non *grandis* Nelson 1870).

Miltha (*Milthoidea*) *grandis* (Hooper Woods, 1931). Singleton and Woods, 1934. Proc. Roy. Soc. Vict., **46**, (n.s.), (2), p. 208-210, pl. 8, fig. 1-3.

Miltha grandis N. H. Woods. Chavan, 1938. Jour. de Conch, **82**, (3), p. 230.

Milthoidea hora (nom. mut. for *grandis* preocc.) Cotton, 1947, Rec. S. Aust. Mus., **8**, (4), p. 663.

Diagnosis—Large, solid, slightly convex, sculpture of irregular numerous raised threads about 1 mm. apart in the adult portion of the shell, the interspaces with one or more fine threads crossed by fine radials. Hinge plate with broad, triangularly elongate ligament groove and triangular area for resilium. Lunule deeply impressed, transgressing hinge area.

Dimensions (estimated)—Length 70, height 70 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Syntypes—Tate Mus. Coll., Univ. of Adelaide, T 1687.

Observations—It is almost impossible to get complete specimens of this large and characteristic species, owing to the fact that shells of such size are invariably shattered by the percussion drill. Chavan (1938, p. 230) has placed the species in *Miltha*, and elsewhere (p. 656) has expressed the opinion that *Milthoidea* is synonymous with *Miltha*. M. Chavan has confirmed this in a personal communication, stating that he is unable to recognize good criteria for separating *Milthoidea* from *Miltha*. The juvenile specimen from Hindmarsh Bore seems at least conspecific with the Flinders Island example described by Singleton and Woods as *Miltha* (*Milthoidea*) *grandis flindersiana*, probably also a juvenile.

Material—Four hypotypes, one of which is a juvenile, Hindmarsh Bore. One hypotype, Kooyonga Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide, South Australia; Flinders Island.

Genus Divalucina Iredale, 1936

Divalucina Iredale, 1936. Rec. Aust. Mus., 19, p. 273.

Type species (monotypy) *Lucina cumingi* Adams and Angas

Divalucina cumingi (Adams and Angas)

pl. 3, fig. 9

Lucina (*Cyclas*) *cumingi* Adams and Angas, 1863. Proc. Zool. Soc., p. 426, pl. 37, fig. 20.
Lucina dentata Wood. Tate, 1886. Trans. Roy. Soc. S. Aust., 8, pl. 12, fig. 3.
Lucina quadrisulcata d'Orbigny. Tate, 1887. *id.* 9, 145.
Lucina quadrisulcata d'Orbigny. Dennant and Kitson, 1903 Rec. Geol. Surv. Vict., 1, (2), p. 139, 147.
Divaricella quadrisulcata d'Orbigny. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55 p. 151.
Divalucina entypoma Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 663, pl. 20, fig. 9, 10.

Diagnosis—Orbicular, truncated posteriorly, longer than high, finely sculptured with divaricate ridges which are approximately 4 per mm. near the umbo and become progressively more distant towards the ventral margin; at 20 mm. from the umbo about 1 per mm.; distances somewhat variable between individuals; ridges generally becoming abruptly obsolete near the anterior dorsal margin.

Dimensions—Length 41, height 38·5 mm.

Type Locality—St. Vincent Gulf, South Australia; Recent.

Location of Holotype—Brit. Mus. (Natural History).

Observations—This is one of the commonest species in the Dry Creek Sands. The writer has compared a number of examples from Weymouth's Bore with the Adams and Angas type and also with a range of examples of *cumingi* from Tasmania and from Sydney Harbour, and is convinced that the fossil examples are essentially the same species. In his diagnosis of the new species *entypoma* Cotton has stated that the fossil species is closely related to the South Australian Recent species *cumingi* though differing in fineness of sculpture. On fitting fossil specimens against the holotype one finds that the sculpture over the same portion of the shell is the same in both. The number of ridges per 10 mm. (measured at the angle of the divaricate sculpture) in the last 10 mm. of an Adelaide shell is 20, and the number of ridges in the corresponding portion of the holotype (measured at the same distance from the umbo) is 20. The reason for the apparent difference in fineness of sculpture is that the number of ridges so measured decreases towards the ventral margin with the increasing size of the shell. The holotype of *D. cumingi* is a large shell for the species, approximately double the size of the average fossil specimen. Specimens of *cumingi* from

Tasmania and from New South Wales are somewhat larger than, but otherwise similar to those from the Dry Creek Sands. The relative dimensions of the holotype and a typical Dry Creek Sands specimen are as follows:

	Holotype	Dry Creek Sands Specimen
Height - - - -	38·5 mm.	19 mm.
Length - - - -	41	20·5
Inflation - - - -	20	10

The genus *Divalucina* was created by Iredale for *Divaricella cumingi* on the absence of a deep pseudo-lunule, the presence (not absence as stated by Cotton, 1947, p. 664) of notable lateral teeth and the size of the cardinals. The ornamentation of *Divaricella* is of raised sharp ribs, of *Divalucina* imbricating ridges.

Material—Holotype, 6 valves Sydney Harbour, 6 valves Tasmania, 16 valves Hindmarsh Bore, 26 valves Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—New South Wales and South Australia.

Family UNGULINIDAE

Subfamily UNGULININAE

Genus DIPLODONTA Bronn, 1831

Diplodonta Bronn, 1831. Erget. nat. Reisen, 2, p. 484.
Diplodonta Bronn, Thiele, 1935. Handb. Syst. Weicht., p. 863 (synonymy).

Type species (s.d. Gray 1847) *Venus lupina* Brocchi

Subgenus DIPLODONTA s.str.

Diplodonta (Diplodonta) solitaria N. H. Woods

pl. 6, fig. 4

Diplodonta solitaria N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 149, pl. 8, fig. 3.
Zemysia solitaria Hooper Woods, Cotton, 1947, Rec. S. Aust. Mus., 8, (4), p. 654.

Diagnosis—Orbicular, fairly stout, only moderately convex, higher than long. Umbo subcentral.

Dimensions—Length 22·8, height 26·7 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. T 1685.

Observations—There are no further specimens of this species described from Abattoirs Bore material. Its identity with "*D. subquadrata* Tate" has been queried (Cotton, 1947, p. 654). The specific name *subquadrata* being preoccupied by Carpenter (1855, Proc. Zool. Soc., p. 230) for a Californian shell, Tate's *subquadrata* was renamed *D. balcombensis* by Pritchard (1906, Vict. Nat., 23, p. 119). *D. solitaria* is orbicular and not subquadrate.

It is a fairly large stout shell, higher than long, with the umbo subcentral. *D. balcombensis* is a thin, inequilateral shell, longer than high, with the umbo at about one-third from the anterior border; one specimen in the British Museum measures, length 23·5, height 22 mm.—about twice the size of the holotype. *Zemysia* was introduced by Finlay for *Lucina zelandica* Gray, no generic diagnosis being given. Thiele has placed it in synonymy with *Diplodonta*. The writer has not been able to examine the New Zealand lineages quoted by Finlay, but considers that South Australian shells at least are *Diplodonta*, congeneric with the type species *D. lupina* (Brocchi). *D. tasmanica* is very close to the Californian *D. subquadrata* Carpenter.

Material—Holotype, T 1685.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Genus NUMELLA Iredale, 1924

Numella Iredale, 1924. Proc. Linn. Soc. N.S.W., 49, (3), p. 206.

Type species (o.d.) *Mysia adamsi* Angas

Numella suborbicularis (Tate)

Sacchia suborbicularis Tate, 1887. Trans. Roy. Soc. S. Aust., **9**, p. 147, pl. 8, fig. 10 a-c.
Mysia (*Felania*) *suborbicularis* Tate, 1894. Jour. Roy. Soc. N.S.W., **27**, p. 187.
Diplodonta suborbicularis Tate (sp.) Harris, 1897. Cat. Tert. Moll. Brit. Mus., **1**, p. 376.
Diplodonta suborbicularis Tate. Dennant and Kitson 1903 .Rec. Geol. Surv. Vict., 1, (2), p. 125, 139.

Diagnosis—Triangularly orbicular, rounded posteriorly and somewhat produced anteriorly. Umbones smooth, remainder of shell with distant growth folds.

Dimensions—Length 7·5, height 8, inflation (one valve) 3·75 mm.

Type Locality—Oyster Beds, River Murray Cliffs; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1081.

Material—Three valves, Lower Beds, Muddy Creek, B.M. Coll.

Stratigraphical Range—Miocene and Pliocene.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide South Australia.

Subfamily THYASIRINAE

Genus Thyasira Lamarck, 1818

Thyasira Lamarck (ex Leach MS), 1818. Anim. s. Vert., **5**, p. 492.
Thyasira Lamarck. Thiele 1935. Handb. Syst. Weicht., p. 864 (synonymy).

Type species (monotypy) *Tellina flexuosa* Montagu

Thyasira sinuata (N. H. Woods)

pl. 6, fig. 6

Cryptodon sinuatum N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 149, pl. 8, fig. 6.

Diagnosis—Small thin, very inflated, sculptured only with growth striae, anterior border truncate, posterior with two folds.

Dimensions—Length 8·1, height 8·2 mm.

Type Locality—Abattoirs Bore, Adelaide, S. Australia; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1653.

Observations—The genus *Cryptodon* Turton, 1822, in which this species was originally described, is, among others, a synonym of *Thyasira*. The full synonymy of the genus is given in Thiele, 1935, p. 864.

Material—Holotype T 1653.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore.

Superfamily LEPTONACEA

Family KELLIIDAE

Genus Bornia Philippi, 1836

Bornia Philippi, 1836, Enum. Moll. Sicil., **1**, p. 18.

Type species (o.d.) *Erycina corbuloides* Philippi

Bornia trigonale (Tate)

pl. 3, fig. 10

Lepton trigonale Tate, 1879. Trans. Phil. Soc. Adel. for 1878/9, p. 131, pl. 5, fig. 9.
Lepton trigonale Tate, 1890 a. Trans. Roy. Soc. S. Aust., **13**, (2), p. 175.
Lepton trigonale Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 146.
Lepton trigonale Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Triangularly ovate, somewhat flattish, smooth in the middle but shagreened or punctate marked on the anterior and posterior sides.

Dimensions—Length 3·8, height 3·5 mm.

Type Locality—Holdfast Bay, South Australia; Recent.

Location of Holotype—S. Aust. Mus., Reg. No. 12904.

Observations—Although not numerous, this shell has appeared in all the bores examined. It was also recorded by Tate as frequent in the Dry Creek Bore.

Material—One valve, Weymouth's Bore, 3 valves Hindmarsh Bore, 3 valves Abattoirs Bore. Eight valves South Australia, 12 valves Victoria, Recent B.M. Coll.

Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—Southern Australia.

Family ERYCINIDAE

Genus LITIGIELLA Monterosato, 1909

Litigiella Monterosato, 1909, Journ. de Conch., 56, (4th ser. 10), p. 254.
Type species (Monotypy) *Erycina cuenoti* Lamy = *Lepton glabrum* Fischer

Litigiella adelaidensis sp. nov.

pl. 3, fig. 11

Lepton crassum Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—A small, subovate, moderately thick, moderately solid, gently convex *Litigiella*. Umbo post-median, inconspicuous, slightly inflated. Surface shining, smooth but for fine concentric growth lines. Anterior and posterior margins rounded, ventral margin nearly straight, dorsal margin gently arched. Adductor scars and pallial line inconspicuous. Right valve with a very small and inconspicuous anterior cardinal and a long posterior and anterior lateral separated by a deep subumbonal inflexion in the hinge.

Paratype—Left valve with the hinge slightly broken in the posterior. A single strong cardinal, posterior lateral and anterior lateral.

Dimensions—Length 4·5, height 3·5, inflation (one valve) 1 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Location of Holotype and Paratypes—Tate Mus. Coll., Univ. of Adelaide. F 15133.

Observations—The Dry Creek Sands species is differently sculptured from the probable Miocene species with which it is formerly identified. It is nearly smooth, and lacks the concentric grooves and ridges of *Litigiella crassa* (Tate).

Material—Holotype and two paratypes.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Abattoirs Bores, Adelaide.

Genus MYLLITA d'Orbigny and Recluz, 1850

Myllita d'Orbigny and Recluz, 1850, Journ. de Conch., 1, (3), p. 288.
Type species (monotypy) *Myllita deshayesi* d'Orbigny and Recluz.

Type species (monotype) *Myllita deshayesi* d'Orbigny and Recluz.

pl. 3, fig. 12

Diagnosis—Elongate-ovate, sculptured with about 23 concentric lirae obsolete anteriorly and posteriorly and bifurcating radial striae which are dominant on the anterior and posterior.

Description of Holotype (right valve)—Shell small, fairly solid, elongate-ovate, inequilateral, anteriorly dilated and rounded. Posteriorly narrower and more sharply ovate. Umbo small, smooth, somewhat depressed. Surface sculptured with about 23 concentric lirae prominent in the middle and becoming obsolete both anteriorly and posteriorly; interspaces crossed by very fine radial striae. On the anterior and posterior areas the radial striae gradually increase in strength and length and soon cross and dominate the concentric sculpture, producing the effect of bifurcating lirae curving concave to the dorsal margin. Hinge with no cardinal but two lateral teeth and two long lateral pits for the reception of the left laterals.

Dimensions—Length 3·8, height 2·6, inflation (1 valve) 1 mm.

Paratype (left valve)—Hinge with a single sharp almost vertical cardinal tooth and two strong laterals.

Dimensions—Length 3, height 2·4, inflation (1 valve) 0·8 mm.

Type Locality—Hindmarsh Bore, Adelaide, 450-487 feet; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, F 15134.

Material—Holotype and paratype only, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Family LEPTONIDAE

Genus Properycina Cerulli-Irelli, 1908

Properycina Cerulli-Irelli, 1908. Pal. Ital., 14, p. 6.

Type species (s.d.) *Erycina mariana* Cerulli-Irelli

Properycina micans (Tate)

pl. 6, fig. 15

Kellia micans Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 148, pl. 19, fig. 13.
Kellya micans Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 139.
Erycina micans Tate. Chapman and Crespin, 1928. Rec. Geol. Surv. Vict., 5, (1), p. 157.
Erycina micans Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis — Minute, transversely ovate, anterior side produced, dorsal margins oblique, ventral margin rounded. Surface sculpture of concentric striae.

Dimensions—Length 3, height 2·5, inflation (one valve) 2 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T. 1077.

Material—Holotype and three paratypes; 5 valves, Abattoirs Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Properycina torrensensis, sp. nov.

pl. 3, fig. 13

Diagnosis—Flattish, transversely oval, smooth, equilateral.

Description of Holotype (right valve)—Shell small, thin, smooth, equilateral. Umbo very small, depressed, scarcely projecting above the dorsal margin. Hinge narrow, with one oblique cardinal tooth beneath the umbo, a long posterior lateral and a shorter but prominent anterior lateral. Shell very slightly produced anteriorly; evenly rounded posteriorly. Anterior-dorsal margin slightly more oblique than posterior; ventral margin straight. Surface smooth but not shining, under magnification showing weak concentric growth folds and microscopic irregular pittings.

Dimensions—Length 7, height 5·1, inflation (1 valve) 1 mm.

Paratype (left valve)—Hinge with an obsolete cardinal visible only in oblique light and one very weak lateral on either side, bordering the lower edge of the hinge. Grooves for the reception of the laterals of the right valve well marked.

Dimensions—Length 5·5, height 4, inflation 0·8 mm.

Type Locality—Hindmarsh Bore, 450-487 feet; Pliocene.

Location of Holotype and Paratypes—Tate Mus. Coll., Univ of Adelaide. F 15135.

Material—Holotype, two paratypes.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore.

? Platomysia sp.

A single right valve, conspicuously concentrically lirate.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore.

Genus MONTACUTA Turton, 1822

Montacuta Turton, 1822. Conch. Insul. Brit., p. 58.
Coriareus Hedley, 1907. Rec. Aust. Mus., **6**, (4), p. 301.

Type species (s.d. Gray, 1847) *Ligula substriata* Montagu

Montacuta sericea Tate

pl. 3, fig. 15

Montacuta sericea Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 148, pl. 14, fig. 6.
Mysella sericea Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 124, 139.
Montacuta sericea Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Rochefortia donaciformis Angas. N. H. Woods, 1931, ibid.
Montacuta sericea Tate. Crespin, 1943. Min. Res. Surv. Bull., **9**, p. 93.
Coriareus sericea Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 654.

Diagnosis—Very inequilateral, rather solid, glossy. Umbones sited at one-quarter total length from anterior edge, small, curved anteriorly.

Dimensions—Length 6·5, height 5, inflation (both valves) 3 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Kalimnan.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. Numerous specimens, Abattoirs Bore, 7 valves.

Material—Hindmarsh Bore.

Stratigraphical Range—Miocene and Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus MYSELLA Angas, 1877

Mysella Angas, 1877. Proc. Zool. Soc., p. 176, pl. 26, fig. 22.
Rochefortia Velain, 1877. Arch. Zool. exp. gen., Paris, **6**, p. 132.

Type species (monotypy) *Mysella anomala* Angas

Mysella anomala Angas

pl. 3, fig. 14

Mysella anomala Angas, 1877. Proc. Zool. Soc., p. 176, pl. 26, fig. 22.
Mysella anomala Angas. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 146.
Rochefortia anomala Angas. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Triangularly ovate, compressed towards the ventral edge, very finely and regularly concentrically ridged; umbo at about one-quarter to one-third length from anterior edge.

Dimensions—Length 9·5, height 7, inflation (both valves), 3 mm.

Type Locality—Shark Island, Port Jackson, 12 fathoms; Recent.

Location of Holotype—B.M. Coll.

Observations—Fossil specimens are somewhat narrower than typical *anomala*.

Material—Holotype, 1 paratype, Shark Island, 1 complete specimen and 3 valves, S. Australia. Recent, B.M. Coll., 3 valves Abattoirs Bore, 1 valve Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—New South Wales to South Australia.

Mysella ovalis Tate

Mysella ovalis Tate, 1892. Trans. Roy. Soc. S. Aust., **15**, p. 128.
Mysella ovalis Tate. N. H. Woods, 1931, *id.*, **55**, p. 151.

Diagnosis—Transversely oval, hinge line arched, the anterior slope incurved and shorter than posterior, which is straight. Anterior margin truncately rounded, posterior somewhat pointed. Uumbones antemedian.

Dimensions—Length 14·5, height 10, inflation (both valves) 4·25, anterior radius 6, posterior radius 8·5 mm.

Type Locality—Hardwicke Bay, 10 fathoms; Recent.

Location of Holotype—S. Aust. Mus., No. D 12893.

Material—Holotype.
Stratigraphical Range—Dry Creek Sands and Recent.
Geographical Distribution—Beachport - Wallaroo, South Australia.

Mysella macer (N. H. Woods)
pl. 6, fig. 8

Rochefortia macer N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151, pl. 7, fig. 3.

Diagnosis—Broadly subovate, relatively high, somewhat narrowly produced posteriorly, postero-dorsal margin at about 45°.
Dimensions—Length 11·1, height 9·3 mm.
Type Locality—Abattoirs Bore, Adelaide; Pliocene.
Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1679.
Material—Holotype; one specimen Hindmarsh Bore.
Stratigraphical Range—Dry Creek Sands.
Geographical Distribution—Abattoirs and Hindmarsh Bores, Adelaide.

Mysella tellinoides (N. H. Woods)
pl. 6, fig. 7

Rochefortia tellinoides N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 148, pl. 7, fig. 4.

Diagnosis—Narrowly ovate; umbones small, not tumid, situated at about one-third from anterior margin.
Dimensions—Length 5·7, height 3·6 mm.
Type Locality—Abattoirs Bore, Adelaide; Pliocene.
Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1676.
Observations—Except for one right valve from the Hindmarsh Bore, referable to this species, from which it differs in its relative dimensions (length 6·5, height 5 mm.), examples of *Mysella tellinoides* have not been found in any other bore than Abattoirs, from which it was described.
Material—1 right valve, Hindmarsh Bore.
Stratigraphical Range—Dry Creek Sands.
Geographical Distribution—Abattoirs Bore, Hindmarsh Bore.

Suborder **CYCLODONTA**
Superfamily CARDIACEA
Family CARDIIDAE
Subfamily TRACHYCARDIINAE
Genus VASTICARDIUM Iredale, 1927

Vasticardium Iredale, 1927. Rec. Aust. Mus., **16**, (1) p. 75.

Type species (o.d.) *Cochlea nebulosa* Martyn = *Cardium elongatum* Bruguière
Subgenus VASTICARDIUM s.str.

Vasticardium (Vasticardium) submaculosum sp. nov.
pl. 4, fig. 18

Diagnosis—A small thin *Vasticardium* somewhat obliquely ovate, truncated posteriorly, sculptured with 56 fine, radial costae smooth dorsally and ornamented with evenly spaced inbricating scales towards the ventral border. Posterior ornament discrepant, consisting of ten pairs of ribs alternately one smooth and narrow and one sharply tuberculate, each narrower than interspaces.

Description of Holotype (right valve)—Shell small for the genus, rather thin, longitudinally ovate, somewhat depressed, slightly oblique, subequilateral. Anterior margin rounded, posterior margin more rapidly descending and somewhat truncated; ventral margin roundly curving. Umbo fairly high, smooth, incurved, prosogyrate, subcentral. Hinge typical, fairly short, nearly straight, with a prominent cardinal (3b) and one obsolete, divergent, almost horizontal cardinal (3a) and one anterior (LA I) and one posterior lateral (LP I). Nymph

prominent. Sculpture of 56 delicate, evenly-spaced radial costae, slightly wider than interspaces. Costae smooth in the convex umbo-dorsal area, sculptured on the posterior side with regular imbricating scales towards the ventral margin; scales extending over the ribs anteriorly. The posterior 10 short ribs divide and develop into one narrow smooth rib and one sharply tuberculate rib, each narrower than the interspaces. Last three anterior short ribs are tuberculate for almost their entire length. Interior of ventral margin crenulate; posterior margin digitate. Pallial line invisible, adductor impressions prominent, sub-equal.

Dimensions—Length 23·6, height 28·7, inflation (one valve) 8·5 mm.

Type Locality—Weymouth's Bore, Adelaide, 310-330 feet; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F15136.

Observations—This shell is very close indeed to the Recent *Vasticardium maculosum* (Wood) (1835, p. 218, pl. 52, fig. 3) from the Indian Ocean and North Australia. The fossil species is a thinner shell with the following differences from *maculosum* der posterior ribs (one smooth, one tuberculate) are arranged in the fossil so that the smooth narrow rib is above (dorsal) and close to the adjacent tuberculose rib; in the Recent shell the relative positions are reversed and the smooth rib is below the tuberculose rib. For most specimens, the main ribs are more definite and sharply squamose in the fossil. This character, however, varies to a certain degree in the Recent species. The anterior six ribs in *maculosum* are much more definitely tuberculate in contrast to the main ribs than are the corresponding ribs in *submaculosum*. The close relationship between the two species is noteworthy. Both species belong to a group of small species of *Vasticardium* represented also by *V. transcendens* (Melvill and Standen), examples from the Amirante Is., and *V. mauritianum* (Deshayes), examples from the Molluccas. The *V. maculosum* lineage would appear to have degenerated in Recent times in Australia. On the evidence of material available in the British Museum, specimens from North Queensland are all small, and at most half the size of examples of *maculosum* from the Gulf of Oman and Ceylon, and of the fossil *submaculosum*. The type locality of *maculosum* is not exactly known, but examples in the British Museum are Indo-Pacific.

Vasticardium was created by Iredale for *Cochlea nebulosa* Martyn = *Cardium elongatum* Bruguière, a large Indo-Pacific shell. The genus as a whole is Indo-Pacific, with the following generic characters: Shape longitudinally oval, hinge nearly straight, short; sculpture discrepant on posterior slope where ribs are divided and are alternately tuberculate and smooth, main ribs numerous, ornamented with imbricating scales on posterior sides. Posterior margin digitate. The genus is closely related to *Acrosterigma* of Dall (type species *Cardium dalli* Heilprin) from the Tertiary of Florida. The type species of *Vasticardium* has longer hinge than that of *Acrosterigma dalli*; the shell is more ovoid, the umbo more tumid and the cardinal teeth less divergent. The subumbonal median internal rib of *Acrosterigma* is not present in *Vasticardium* nor is there the internal umbonal-post-ventral rib-like thickening which occurs in *A. dalli*.

Material—Holotype, Weymouth's Bore, one broken left valve Thebarton Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's and Thebarton Bores, Adelaide.

Subgenus REGOZARA Iredale, 1936

Regozara Iredale, 1936. Rec. Aust. Mus., 19, p. 275.

Type species (o.d.) *Regozara olivifer* Iredale

Vasticardium (Regozara) praecygnorum sp. nov.

pl. 4, fig. 12

Cardium cygnorum Deshayes. Tate, 1890 a. Trans. Roy. Soc. S. Aust., 13, p. 175.
Cardium cygnorum Deshayes. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 146.
Cardium cygnorum Deshayes. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—A small *Regozara*, roundly ovate, sculptured with 48 radial ribs of which the posterior seven are narrow, with a row of widely spaced scales in the interspaces. Ribs elsewhere flatly rounded, with narrow interspaces, sculptured on the posterior side only with narrow widely spaced diagonal ridges which extend further across the rib towards the anterior where they are almost tuberculate. Interspaces crossed by growth lamellae which show as indistinct striae on the ribs.

Description of Holotype (right valve)—Shell small, rather thin, but immature, roundly ovate, subequilateral, umbo prominent incurved, subcentral. Hinge of moderate length, gently curved, with a prominent cardinal (3a), one anterior (LA I), and one posterior (LP I) lateral. Nymph broken in holotype but prominent. Sculpture of 48 radial costae, the posterior seven of which are narrow with a row of widely-spaced scales in the interspaces. Ribs elsewhere flatly rounded with narrow interspaces with steep sides, sculptured on the posterior side only with fairly smooth and widely spaced diagonal ridges which extend further across the ribs towards the anterior where they are almost tuberculate. Interspaces crossed by frequent growth lamellae which show as indistinct striae on the ribs. Interior of ventral margin crenulate, posterior margin digitate.

Dimensions—Length 22·5, height 23·5, inflation (one valve) 9 mm.

Type Locality—Dry Creek Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F15137.

Paratype—The holotype is an immature shell and a larger broken specimen is selected from the tablet of six specimens mounted by Tate from Dry Creek Bore, with the following dimensions: Length 33, height (estimated) 35 mm.

Observations—This species has now been compared with the holotype and two paratypes of "*Cardium*" *cygnorum* Deshayes, and is distinct from that species. "*C*". *cygnoum* is a large shell with 45 radial costae which are ornamented on both sides over all the shell. Iredale (1936, p. 276) has pointed out that New South Wales shells referred to "*Cardium*" *cygnorum* (typically from Western Australia) are not referable to *cygnorum*. From examination of a limited number of specimens in the British Museum, the writer is inclined to agree with this opinion; the species described above as *praecygnorum* appears to be more closely related to the New South Wales "*cygnorum*" than to *cygnorum* s. str.

Material—Holotype and five paratypes, Dry Creek Bore; many fragments Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Dry Creek and Abattoirs Bores, South Australia.

Subfamily LAEVICARDIINAE

Genus Fulvia Gray, 1853

Fulvia Gray, 1853 Ann. Mag. Nat. Hist., Ser. 2, 11, p. 40.

Type species (monotypy) *Cardium apertum* Bruguière

Fulvia tenuicostata (Lamarck)

pl. 4, fig. 13

Cardium tenuicostatum Lamarck, 1819. Anim. s. Vert., 6, (1), p. 5.
Cardium racketti Donovan, 1825. Nat. Repos., 4, pl. 124.
Cardium tenuicostatum Sowerby, 1832. Conch. 111, 5, fig. 19, 36, 62.
Cardium tenuicostatum Lamarck. Delessert, 1841. Rec. de Coq. par Lamarck, pl. 11, fig. 6.
Cardium tenuicostatum Lamarck. Reeve, 1843. Conch. Icon., 11, pl. 10, fig. 50.
Cardium tenuicostatum Lamarck. Catlow and Reeve, 1845. Conch. Nomen., p. 45.
Cardium tenuicostatum Lamarck. Tate, 1890 a. Trans. Roy. Soc. S. Aust., 13, (2), p. 175.
Cardium tenuicostatum Lamarck. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 146.
Cardium racketti Donovan. Hedley, 1917. Proc. Linn. Soc. N.S.W., 41, (4), p. 685.
Cardium racketti Donovan. May 1921. Check List, p. 22.
Cardium racketti Donovan. May 1923. 111. Ind., p. 23, pl. 9, fig. 15.
Cardium racketti Donovan. Cotton and Godfrey, 1938. Moll. S. Aust., 1, p. 227.

Diagnosis—A thin fragile, ventricose, quadrately-orbicular *Fulvia* swollen at the umbones, sculptured with from 45 to 50 fine smooth axial costae, equal to the interspaces which are faintly crossed by concentric growth striae.

Description of Hypotype (Dry Creek Bore)—Shell ventricose thin, fragile, quadrately orbicular, umbo prominent, prosogyrate, smooth. Surface of shell sculptured with 46 fine smooth radial ribs, sharply defined and equal to the interspaces, which are crossed by concentric growth striae. Posterior area somewhat discrepant with sculpture in the interspaces generally more prominent and inclined to be more widely spaced. There is a narrow smooth triangular area at both the posterior and anterior borders. Posterior margin smooth, not digitate.

Dimensions of Hypotype—Length 19, height 19 mm.

Dimensions of Hylotype—Length 56 mm.

Type Locality—Timor.

Location of Holotype—Mus. Hist. Nat., Paris.

Observations—Hedley (1917, p. 685) has advanced reasons for rejecting Lamarck's name *tenuicostata* and replacing it by Donovan's *racketti* for Australian shells, on the grounds that Delessert's figure represents a differently shaped shell, which cannot be identified. This is incorrect. The holotype of *tenuicostata* is lodged in the Lamarck Collections in the Natural History Museum in Paris where it was seen by the writer. Most of the examples of *tenuicostata* in the British Museum agree with Delessert's figure of the holotype in which the characteristic roseate colouring of the umbonal area is reproduced. The general shape of a wide range of specimens is that of Lamarck's type. One example from Port Jackson is slightly narrower and more abruptly sloping posteriorly, like the shell figured by Donovan. Hedley has also argued that Delessert's specimen is larger than Donovan's *racketti*. This surely is not a valid reason for rejecting a species; in any case, specimens from Western Australia are over 50 mm. in width. The rejection of *tenuicostata* on purely geographical grounds is fallacious.

It is difficult to reconcile the green colouring of Donovan's figure with the familiar white and pink colour of *tenuicostata*, and as the holotype of *racketti* has disappeared, its identification is impossible; the use of the name *racketti* for the Australian shell should be abandoned.

Reeve (1843, pl. 10, fig. 50) has noted that the number of ribs varies between individuals. Both Lamarck's and Donovan's shells have 47-48 ribs; the writer has counted over 50 in some specimens.

The species is represented in the Dry Creek Sands by four small examples from Dry Creek Bore, which show some slight divergence by having the interspaces somewhat more heavily crossed by concentric growth striae in the posterior area in most specimens.

Material—Holotype. The figured hypotype and three other specimens. Dry Creek Bore; numerous specimens. Recent, Australia, B.M. Coll.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—Australia generally; Indo-Pacific (Challenger Expedition).

Subfamily PROTOCARDIINAE

Genus Nemocardium Meek, 1876

Nemocardium Meek, 1876. Dep. Int. Rep. U.S. Geol. Surv. Terr., 9, p. 167.

Type species (s.d. Sacco, 1899) *Cardium semiasperum* Deshayes.

Subgenus Pratulum Iredale, 1924

Pratulum Iredale, 1924. Proc. Linn. Soc. N.S.W., 49, p. 182.

Type species (o.d.) *Cardium thetidis* Hedley

Nemocardium (Pratulum) proterothetidis sp. nov.

pl. 3, fig. 16, 17

Cardium hemimeris Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Small, quadrately orbicular, longer than high. Umbo incurved, very slightly prosogyrate. Posterior tuberculate ornament over a little more than one-third of shell, with about 32 fine tuberculate ribs. Remainder of shell with fine smooth radials about 6 per mm. There is a marked umbo-post-ventral sulcus and a corresponding post-ventral insinuation.

Description of Holotype—Left valve. Shell thin, small, broadly quadrately ovate, longer than high, subglobose; umbo submedian, elevated, smooth, incurved and only very slightly prosogyrate. Ornament discrepant, posterior siphonal area a little more than one-third of shell with about 32 (5 per mm. ventrally) fine tuberculate radiating ribs; remainder of shell with very fine smooth radials, about 6 per mm. measured at the ventral margin, faintly and irregularly crossed by concentric growth striae. There is a marked umbo-post-ventral broad sulcus, producing a corresponding insinuation at the post-ventral margin. Dorsal margin gently rounded, anterior margin rounded, ventral margin only slightly rounded; posterior margin somewhat truncate, insinuate. Interior crenate all round. Hinge arched, narrow, with a prominent cardinal (2) and very small posterior cardinal (4b). Laterals (A II and P II) triangular and rather weak.

Dimensions—Length 9, height 8, inflation (one valve) 3 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F15138.

Observations—This is not the Janjukian-Balcombian *N.* (*P.*) *hemimeris* (Tate), as formerly identified. *N.* (*P.*) *hemimeris* is higher than long, has a much more strongly curved umbo, markedly prosogyrate, while the tuberculate posterior sculpture extends over half the valve. *N.* (*P.*) *proterothetidis* approximates more closely to the Recent *thetidis* Hedley, from which it differs in having a less inflated umbo, a longer hinge line and weaker marginal crenulations. The umbo-post-ventral sulcation is well marked in *proterothetidis* but is only faintly present in *thetidis*. The posterior margin is shorter and less oblique and there is not the tendency for the post-ventral margin to be produced as in *thetidis*.

Material—Holotype, Abattoirs Bore; 1 valve Hindmarsh Bore, 6 valves Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Suborder TELEODONTA

Superfamily VENERACEA

Family DOSINIIDAE

Subfamily DOSINIINAE

Genus Dosinia Scopoli, 1777

Dosinia Scopoli, 1777. Introd. Hist. Nat., Prague, p. 399.

Type species (s.d. Gray, 1847) *Venus exoleta* Linné

Subgenus Kereia Marwick, 1927

Kereia Marwick, 1927. Trans. N.S. Inst., 57, p. 583.

Type species (c.d.) *Dosinia greyi* Zittel

Dosinia (Kereia) johnstoni Tate

Dosinia johnstoni Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 161, pl. 14, fig. 9, 12.
Dosinia johnstoni Tate. Tate and Dennant, 1983. *id.* 17, (2), p. 225.
Dosinia johnstoni Tate. Dennant and Kitson, 1903. Rec. Geol. Surv., Vict., 1, (2), p. 125, 139.
Dosinia johnstoni Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Dosinia johnstoni Tate. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 92.

Diagnosis—Sculptured with regular, thick, depressed concentric ridges, with reflexed acute edges, separated by deep linear sulci about 20 per 10 mm. near the ventral edge.

Dimensions—Length 27, height 25, inflation (one valve) 7 mm.
Type Locality—Upper Beds, Muddy Creek, Victoria; Pliocene.
Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1159.
Material—One complete specimen, 3 broken valves. Abattoirs Bore.
Stratigraphical Range—Miocene and Pliocene.
Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Family MERETRICIDAE

Subfamily MERETRICINAE

Genus NOTOCALLISTA Iredale, 1924

Notocallista Iredale, 1924. Proc. Linn. Soc. N.S.W., **49**, p. 182.

Type species (o.d.) *Cytherea kingi* Gray

Subgenus STRIACALLISTA Marwick, 1938

Striacallista Marwick, 1938. Trans. Roy. Soc. N.Z., **68**, p. 68.

Type species (o.d.) *Cytherea multistriata* Sowerby

Notocallista (Striacallista) mollesta Marwick

pl. 5, fig. 2

Macrocallista submultistriata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151 (pars).
Notocallista (Striacallista) mollesta Marwick, 1938. Trans. Roy. Soc. N.Z., **68**, p. 73, pl. 13, fig. 7-9.

Diagnosis—Umbones low, sculpture of fine, regular concentric grooves and bevelled ridges 4-5 per mm. persisting across the disk. Ligament deep with high walls.

Dimensions—Length 26·5, height 19·5, inflation (one valve) 6·5 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—N.Z. Geol. Surv. Coll., Wellington, N.Z.

Material—Hypotype (figured) Abattoirs Bore. Two valves Weymouth's Bore; 2 valves Thebarton Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Notocallista (Striacallista) pestis Marwick

pl. 5, fig. 3

Notocallista (Striacallista) pestis Marwick, 1938. Trans. Roy. Soc. N.Z., **68**, p. 73, pl. 13, fig. 3, 4.

Diagnosis—Umbones moderately conspicuous, sculpture of concentric grooves and ridges about 4 per mm. on the anterior and posterior parts and dying out over the middle of the disk. Ligament shallow, walls low.
Dimensions—Length 27, height 19, inflation (one valve) 5·5 mm.
Type Locality—Abattoirs Bore, Adelaide; Pliocene.
Location of Holotype—Auckland Museum, New Zealand.
Material—Four valves Weymouth's Bore, 1 valve Thebarton Bore.
Stratigraphical Range—Dry Creek Sands.
Geographical Distribution—Adelaide District.

Family VENERIDAE

Subfamily VENERINAE

Genus ANTIGONA Schumacher, 1817

Antigona Schumacher, 1817. Ess. Nouv. Syst. vers. Test, p. 155.
(*Proxichione* Iredale, 1929b. Aust. Zool., **5**, (4), p. 339.)

Type species (monotypy) *Antigona lamellaris* Schumacher

Subgenus ANTIGONA s.str.

Antigona (Antigona) cognata (Pritchard)

Chione cognata Pritchard, 1903. Proc. Roy. Soc. Vict., **15**, (2), 101, pl. 12, fig. 5.
Antigona dimorphylla Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Very large, solid, moderately tumid, umbo broad and only somewhat inflated, at anterior one-fourth, strongly directed anteriorly but not markedly incurved. Lunule impressed, finely lamellose, bounded by incised line. Ligament groove deep and long. Sculpture of high concentric lamellae corrugated anteriorly and posteriorly and numerous interstitial redials broader than inter spaces.

Dimensions—Length 68, height 53 mm.

Type Locality—Grange Burn, near Hamilton, Victoria; Pliocene.

Location of Holotype—Melb. Univ. Geol. Dept., No. 1755.

Observations—Although in small numbers, the species has appeared in Abattoirs, Hindmarsh and Kooyonga Bores. Material under present observation is fragmentary, as the shells have been broken by the percussion drill, and accurate diagnosis is difficult. Previously, Adelaide examples have been placed in *dimorphophylla* (Tate), but on closer examination of a series of topotypes and other specimens of *dimorphophylla* it is considered that they have been wrongly placed and should be placed in *cognata*. The umbo of the present species is broader and less inflated than that of *dimorphophylla* and it is not so markedly incurved. The specimens are larger than *cognata* from the type locality and much heavier and more solid than *dimorphophylla;* estimated dimensions are length 82, height 65 mm. They very strongly resemble the Recent Indo-Pacific species *A. listeri* (Gray) and *A. reticulata* (Linné) the concentric lamellae are further apart than they are in *listeri* and the interstitial radials are finer and more closely set. The shape of the pallial sinus is more angular in *cognata* than in either *listeri* or *reticulata*.

Material—Two broken valves, Hindmarsh Bore; 2 broken valves Kooyonga Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Dosina Gray, 1835

Dosina Gray, 1835, in Yate, Account N.Z. Shells, p. 309.
(*Dorsina* Gray, 1840. Syn. Cont. Brit. Mus., ed. 42, p. 149.)
(*Dosinula* Finlay, 1926. Trans. N.Z. Inst., 57, p. 470.)

Type species (monotypy) *Dosina zelandica* Gray

Subgenus Hina Marwick, 1927

Hina Marwick, 1927, Ibid., p. 602.

Type species (o.d.) *Marama pinguis* Marwick

Dosina (Hina) cainozoica Tenison-Woods [1]

pl. 5, fig. 5

Venus (Chione) cainozoica Tenison-Woods, 1877. Proc. Roy. Soc. Tas. for 1876, p. 113.
Chione cainozoica Tenison-Woods. Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 156, pl. 16, fig. 3 a-b.
Chione cainozoica Tenison-Woods. Johnston, 1888. Geol. Tas., p. 233, pl. 32, fig. 8-8 a, 11-11 a.
Chione cainozoica Tenison-Woods. Tate and Dennant, 1893. Trans. Roy. Soc. S. Aust., **17**, (1), p. 225
Chione cainozoica Tenison-Woods. Tate and Dennant, 1895, *id.*, **19**, (1), p. 113.
Chione cainozoica Tate. Pritchard, 1896. Proc. Roy. Soc. Vict., **8**, (n.s.), p. 135.
Chione cainozoica Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 125, 147.
Callanaitis cainozoica T. Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Somewhat globose, ornamented with numerous fine concentric threads, which at intervals are raised and lamellous; lamellae close and more

[1] Listed in Part I, p. 57, as *Antigona (Hina) cainozoica*.

numerous at anterior and posterior margins, thin and fragile; inter-lamellar threads are fine and equidistant. Inner ventral margin very finely crenulate; antero-dorsal margin also very finely crenulate, but not continuously with the ventral margin.

Dimensions—Length 22, height 18, inflation (both valves) 17 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—Hobart Museum, Tasmania.

Observations—A single left valve from Weymouth's Bore belongs to this species which has been recorded also from Abattoirs and Croydon Bores. The Weymouth's Bore specimen, like a large adult specimen from the lower beds at Muddy Creek in the British Museum, shows a strong tendency to fine radial ornament, generally visible between the lirae in the adult portion of the shell, but most obvious on the under side of the lamellae where they have not been broken. The lamellae and lirae become almost frilled where the radials are well developed. The species is evidently long-ranging and very widespread; it has been recorded from almost every locality in Victoria, South Australia, and Tasmania, from Oligocene to Miocene, and survives to the Pliocene of the Dry Creek Sands.

Subfamily CIRCINAE

Genus Gafrarium Röding, 1798

Gafrarium Röding ex Bolten, 1798, Mus. Bolt., p. 176.

Type species (s.d. Dall, 1902) *Venus pectinata* Linné

Gafrarium perornatum N. H. Woods

pl. 6, fig. 9

Gafrarium perornatum N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 148, pl. 7, fig. 7, 8.

Diagnosis—Fairly small, transversely ovate. Umbones at anterior third. Sculpture of fine curving radials, separated by linear interspaces agulated and diverging at anterior third and also at posterior third; curving concavely towards dorsal margin.

Dimensions—length 9·6, height 7·5 mm.

Material—Holotype; one left valve, Weymouth's Bore, five specimens Lower Beds, Muddy Creek, L9888, one specimen L10587, B.M. Coll.

Stratigraphical Range—? Oligocene to Miocene; Dry Creek Sands.

Geographical Distribution—Southern Australia.

Subfamily CHIONINAE

Genus Tawera Marwick, 1927

Tawera Marwick, 1927. Trans. N.Z. Inst., 57, p. 613

Type species (o.d.) *Venus spissa* Deshayes

Tawera pernitida (N. H. Woods)

pl. 6, fig. 5

Antigona pernitida N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 148, pl. 8, fig. 1, 2.
Antigona dictua Tate (?) = *Antigona pernitida* Hooper Woods. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 634.

Diagnosis — Transversely subovate, sculptured with fine, sharp, concentric raised threads, about 5 per mm., becoming lamellose towards the ventral border, with fine radial threads crossing the interspaces. Inner ventral margin finely crenulate all round except above post-dorsal hinge area.

Dimensions—Length 12·3, height 9·4 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1673.

Observations—Cotton has with some justification queried the identity of the above species with *Tawera dictua* (Tate). The two species are similar in

general characters, but the radial sculpture is dominant in *dictua*, while the concentric sculpture is dominant in *pernitida*. Concentric sculpture in *pernitida* is more regular and sharper. *T. dictua* is a narrower shell than *pernitida*, the teeth are differently shaped, the umbo is higher and more inflated in *pernitida*, the hinge is shorter and broader in *pernitida*. It may be that habitat and mode of preservation account for the differences, which are none the less apparent.

Material—Holotypes, and paratypes, Abattoirs Bore, numerous specimens Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Hindmarsh Bores.

Tawera gallinula (Lamarck)

pl. 3, fig. 20

Venus gallinula Lamarck, 1818. Hist. Nat. Anim. s. Vert., 5, p. 592.
Chione propinqua T. Woods, var. Tate, 1890. Trans. Roy. Soc. S. Aust., 13, (2), p. 175.
Chione propinqua T. Woods, var. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 147.
Antigona propinqua Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151 (pars).

Diagnosis—Elongate-ovate, somewhat truncate both anteriorly and posteriorly, sculptured with thin, erect lamellae. Whitish, with reddish-brown angular lines.

Dimensions—Length 35 mm.

Type Locality—King Island, Tasmania; Recent.

Location of Holotype—Mus. Hist. Nat., Paris.

Observations—A single juvenile right valve from Abattoirs Bore formerly classified as *Antigona propinqua* is here referred to the species *gallinula*.

Attention is here drawn to the fact that the figures for the two species *Tawera gallinula* and *Tawera lagopus* in Cotton and Godfrey's "The Mollusca of South Australia" have been transposed.

Material—One valve, Abattoirs Bore. Seven complete specimens locality not specified, and eight complete specimens, Tasmania, B.M. Coll.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—Southern Australia from New South Wales to Western Australia.

Tawera incurvilamellata sp. nov.

pl. 3, fig. 18, 19

Antigona propinqua Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 65, (1), p. 151 (pars).

Diagnosis—A fairly flat *Tawera* with umbo at anterior two-fifths sculptured with raised lamellae about $\frac{3}{4}$ mm. apart, each incurved towards the ventral margin. Radials obsolete.

Description of Holotype (right valve)—Shell fairly small, elongate-oval, inequilateral, somewhat attenuated at the post-ventral edge, fairly flat. Umbo prosogyrate, moderately inflated, incurved, situated about two-fifths from anterior margin. Prodissoconch smooth, shining small. Early part of shell with twelve slightly raised lamellae, five per mm. followed in adult shell by twelve raised lamellae, about three -quarters of a mm. apart, rounded and incurved towards the ventral margin. Towards the posterior border the lamellae flatten out and become somewhat waving as they converge towards the margin. Underneath the overhanging portions, on the ventral side of each lamella are obsolete radial riblets. These extend faintly into the interspaces and are visible only in reflected light. Interspaces with frequent insignificant growth striae. Hinge typical of *Tawera*, well developed. Inner margin finely crenulate. Pedal retractor well marked, separated from anterior adductor. Pallial sinus deep, rounded.

Dimensions—Length 13·6, height 9·5, inflation (one valve) 3 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide. F15139.

Observations—This shell is unlike any other examined. In general shape it bears resemblance to the foregoing shell classified as *T. gallinula,* from which it differs in its very characteristic concentric sculpture which distinguishes it also from the so-called *"Chione" propinqua* of the "Kalimnan." A larger example reaches a length of 20 mm.

Material—The holotype and 11 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Genus PLACAMEN Iredale, 1925

Placamen Iredale, 1925. Rec. Aust. Mus. **14**, (4), p. 225

Type species (monotypy) *Pectunculus fasciatus* Da Costa

Placamen subroborata (Tate)

pl. 4, fig. 2, 3

Chione subroborata Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 156, pl. 14, fig. 17.
Chione subroborata Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., **1**, p. 374.
Chione subroborata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 125, 139, 146.
Clausinella subroborata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Placamen subroborata Tate. Cotton and Godfrey, 1938. S. Aust., p. 238.

Diagnosis—Trigonal, broad in front, subrostrate posteriorly. Sculpture of about 15 concentric lamellae which are rather thick and recurved except on posterior slope where they are erect.

Dimensions—Length 25, height 24, umbo to post-ventral angle 25, inflation (both valves) 14 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1169.

Material—Five valves, Weymouth's Bore, all juveniles; 11 valves, including the figured hypotype Muddy Creek, Victoria, No. L6605, 9884, L4830, L25790; 4 valves, Bairnsdale, L355, B.M. Coll.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus BASSINA Jukes-Brown 1914

Bassina Jukes-Brown, 1941. Proc. Mal. Soc., **11**, p. 81.
(*Callanaitis* Iredale, 1917. *id.* **12**, (6), p. 329.)

Type species (o.d.) *Venus paucilamellata* Sowerby

Bassina allporti (Tenison-Woods)

Venus allporti Tenison-Woods, 1876 a. Proc. Roy. Soc. Tas. for 1875, p. 26, pl. 3, fig. 10.
Chione allporti Tenison-Woods. Tate, 1887 b. Trans. Roy. Soc. S. Aust., **9**, p. 154.
Chione allporti T. Woods. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 125, 139
Bassina allporti T. Woods. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.

Diagnosis—Ovately oblong, anterior subangulated, sculptured with 12 distant lamellae.

Dimensions—Length 29, height 19 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—Hobart Museum.

Material—Two valves, Abattoirs Bore.

Stratigraphical Range—Oligocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus TIMOCLEA Brown, 1827

Timoclea Brown, 1827. Ill. Conch. G.B. & I., pl. 19, fig. 11.

Type species (monotypy) *Venus ovata* Pennant

Subgenus VEREMOLPA Iredale

Veremolpa Iredale, 1930. Rec. S. Aust. Mus., 17, p. 397.
(*Glycydonta* Cotton, 1936. Rec. S. Aust. Mus., 5, (4), p. 503.)

Type species (monotypy) *Veremolpa ethica* Iredale

Timoclea (Veremolpa) protomarica (Cotton)

Glycydonta protomarica Cotton, 1936. Rec. S. Aust. Mus., 5, (4), p. 504, text fig. 1.

Diagnosis—Hinge with twelve Glycymerid-like teeth on either side of the three cardinals; sculpture of about twelve concentric lamellae, with numerous regular, subordinate radial ribs which fimbriate the concentric lamellae.

Dimensions—Length 9, height 7·8, inflation 5·4 mm.

Type Locality—Torrensville Bore 490 feet; Pliocene (cited in original description as 49·0 feet, Upper Pliocene).

Location of Holotype—St. Aust. Mus., Reg. No. D12888.

Observations—This species has apparently not been found since it was described from Torrensville Bore. It is obviously very close indeed to the Indo-Pacific "*Venus*" *marica* Linné which Cotton cited as the type species of *Glycydonta*. The alleged differences between this genus and Iredale's *Veremolpa* seem to be ontogenetic and hardly of generic magnitude.

Material—Holotype.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Torrensville Bore, Adelaide District.

Genus CHIONERYX Iredale, 1924

Chioneryx Iredale, 1924. Proc. Linn. Soc. N.S.W., 49, (3), 197, p. 210.

Type species (o.d.) *Venus striatissima* Sowerby

Chioneryx dennanti (Chapman and Crespin)

pl. 4, fig. 19

Chione striatissima Sowerby. Tate, 1890. Trans. Roy. Soc. S. Aust., 13, (1), p. 175.
Chione striatissima Sowerby. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 146.
Antigona dennanti Chapman and Crespin, 1928. Rec. Geol. Surv. Vict., 5, (1), p. 104, pl. 12, fig. 82.
Antigona striatissima Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Antigona dennanti Chapman and Crespin. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 92.

Diagnosis—Fairly small, umbo at anterior third; adult shell with about 22 waving, slightly raised concentric lamellae, about 16 per cm. Interspaces crossed by strong flattish radial riblets, equal in width to the spaces between them, undulation on the lamellae corresponding to the riblets, and somewhat irregular and undulating concentric growth lines crowding the interspaces between the lamellae.

Dimensions—Length 25, height 19, inflation (both valves) 12 mm.

Type Locality—Jemmy's Point, Lakes Entrance, Victoria; Kalimnan.

Location of Holotype—Dennant Coll., National Museum, Melb.

Description of Hypotype (right valve)—Shell small, solid, transversely oval, umbo prosogyrate, situated one-third of length of shell from anterior margin, somewhat elevated and tumid, incurved. Prodissoconch polished, smooth except for concentric threads, of which there are five, and faint incipient radial riblets. Adult shell with 22 waving, slightly raised concentric lamellae, about 16 per cm. Interspaces crossed by strong flattish radial riblets, equal in width to the spaces between them, the undulations on the lamellae corresponding to the riblets, and somewhat irregular and undulating concentric growth lines crowding the interspaces between the lamellae. Lunule large, nearly smooth, elongate-cordate, bounded by a sharply incised line cutting across the concentric lamellae and

growth lines which continue weakly over the lunule. Escutcheon narrow, long, bounded by a slight ridge. Hinge teeth widely divergent, consisting in the right valve of a small, entire, narrow, moderately strong anterior (3a) parallel to the lunular margin, a median triangular grooved (1), and a strong posterior cardinal, raised and grooved (3b). Pallial sinus short, rounded. Pedal retractor small, separated from the anterior adductor.

Internal margin crenate, with the exception of the posterior dorsal edge.

Dimensions—Length 15·3, height 13·2, inflation (one valve) 4 mm. (left valve). Hinge with a high posterior cardinal (4b), joined to the nymph, subtriangular moderate and unequally divided median (2b), and an entire, high, narrowly-triangular diverging anterior cardinal (2a).

Dimensions—Length 11·1, height 8·8, inflation (one valve) 2·9 mm.

Material—Numerous specimens, Weymouth's Bore.

Observations—This shell has previously been identified as *Venus striatissima* Sowerby (= *Erycina cardioides* Lamarck) the type species of Iredale's genus *Chioneryx*. Iredale (1924, p. 210) has pointed out that in transferring *Erycina cardioides* to *Venus*, Sowerby changed the specific name to *striatissima*, since the name *cardioides* was already preoccupied in *Venus* by Lamarck's *Venus cardioides* (1818, p. 590). With creation of a new genus *Chioneryx* for the species, Iredale advocated a reversion to Lamarck's name *cardioides*. The species is now listed in Australian literature as *Chioneryx cardioides* (Lamarck) (Cotton and Godfrey, 1938, p. 240, *et al.*). It must be pointed out, however, that the name *cardioides* is a suppressed homonym for this species, and cannot be used again (Int. Rules Zool. Nomen., Art 36). Secondly, there has not been universal acceptance of full generic status for *Chioneryx*. In (Thiele, 1935, p. 890) *Chioneryx* is given subgeneric rank under *Venus*, which still leaves *cardioides* as a homonym. In view of these factors, the specific name *striatissima* should be used as formerly and *cardioides* kept suppressed.

The fossil species *dennanti* is superficially like *striatissima* particularly in the external sculpture, but the shape of the shell generally differs in its greater relative height, and it is only occasionally subrostrate; the umbones are higher and more inflated; the marginal crenulations are finer in *dennanti*. The hinge of *dennanti* is intermediate between *Tawera* and *Chioneryx*, the teeth being less divergent than in *Chioneryx*, but nearer to *Chioneryx* than to *Tawera*; the strength of the radial sculpture is intermediate between the two, but nearer to that of *Chioneryx* than to that of *Tawera*. Marwick (1927, p. 613) has suggested that *Chioneryx* may be a Recent development of the *Tawera* stock. Present evidence strongly supports this and *dennanti* is undoubtedly antecedent to *Chioneryx* in the *Tawera-Chioneryx* lineage.

In shape the species *dennanti* is variable; ratio length: height varies from 1·26 in the longer shells to 1·15 in the relatively higher shells.

Materials—About 70 valves, Weymouth's Bore, 4 valves Abattoirs Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Subfamily TAPETINAE

Genus Paphia Röding, 1798

Paphia Röding ex Bolten, 1798. Mus. Bolt., p. 175.

Type species (s.d. Dall, 1902) *Paphia alapapilionis* Röding

Paphia sp.

Paphia fabagelloides Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Observations—A Tate manuscript name appears to have been used for a specimen from Abattoirs Bore. As the single specimen so named has been damaged and description is impossible, the name should be removed from the list of species occurring in the Dry Creek Sands.

Genus VENERUPIS Lamarck, 1818

Venerupis Lamarck, 1818. Anim. s. vert., 5, p. 506.

Type species (s.d. Children, 1823) *Venus perforans* Montagu

Venerupis paupertina Tate

Venerupis paupertina Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 162, pl. 14, fig. 15.
Venerupis paupertina Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 139.
Venerupis paupertina Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 654.

Diagnosis—Umbo large, conspicuous, cordate, lunule well defined; sculptured with flat radial ribs equal to the interspaces.

Dimensions—Length 12, height 7, inflation (both valves) 5 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1206B.

Material—One broken specimen, Abattoirs Bore.

Stratigraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Superfamily TELLINACEA

Family SANGUINOLARIIDAE

Genus GARI Schumacher, 1817

Gari Schumacher, 1817, Ess. Nouv. Syst. Test., pp. 44, 131.
(*Psammobia* Lamarck, 1818, Hist. Nat. Anim., s. Ver., 5, p. 511.)

Type species (tautonymy) *Gari vulgaris* Schumacher = *Tellina gari* Linné

Gari hamiltonensis (Tate)

pl. 4, fig. 17

Psammobia Hamiltonensis Tate, 1885. Southern Science Record, p. 4 (*fide* Tate, 1887).
Psammobia Hamiltonensis Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 167, pl. 16, fig. 13.
Gari hamiltonensis Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 377.
Gari hamiltonensis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 125, 139.
Psammobia hamiltonensis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151
Gari hamiltonensis Tate. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 93.

Diagnosis—Attenuated anteriorly, obliquely truncated posteriorly, post-dorsal margin gently sloping, post-ventral margin roundly curved to meet oblique posterior margin.

Dimensions—Length 31, height 15 mm.

Type Locality—Upper Beds, Muddy Creek, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1190A.

Observations—Both this and the following species have been found in the Abattoirs Bore only.

Material—The figured hypotype, Abattoirs Bore; 10 topotypes, B.M. Coll., Nos. L4819, L9891, L25789.

Stratigraphical Range—? Miocene; Pliocene.

Geographical Distribution—Gippsland, Victoria – Adelaide, South Australia.

Gari aequalis (Tate)

Psammobia aequalis Tate. Southern Science Record, Jan. 1885. p. 4 (*fide* Tate, 1887).
Psammobia aequalis Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 168, pl. 16, fig. 10.
Gari aequalis Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 378.
Gari aequalis Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 125, 139
Psammobia aequalis Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Roundly truncated posteriorly, umbo medial, depressed, no posterior keel.

Dimensions—Length 22, height 11 mm.

Type Locality—Upper Beds, Muddy Creek, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1189B.

Material—Seven topotypes B.M. Coll., Nos. L.4819, L.9891.
Stratigraphical Range—Miocene and Pliocene.
Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Family TELLINIDAE

Genus Macoma Leach, 1819

Macoma Leach, 1819, in Ross, Voy, Dis., Baff. Bay. Appendix 2, pl. 12.

Type species (monotypy) *Macoma tenera* Leach = *Tellina calcarea* Linné

Macoma ralphi (Finlay)

pl. 4, fig. 9, 10

Tellina aequilatera Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 166, pl. 16, fig. 5 a-b, 9 a-b, pl. 20, fig. 19.
Tellina aequilatera Tate. Tate and Dennant, 1893. *id.* 17, (1), p. 225.
Tellina aequilatera Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 187.
Tellina aequilatera Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 127, 139.
Tellina ralphi (Finlay, 1927). Trans. N.Z. Inst., 57, p. 530. *nom. mut.* for aequilatera).

Diagnosis—Somewhat convex, post-dorsal margin straight, more steeply sloping than in front. Anterior margin broadly rounded, slightly incurved; posterior narrower, abruptly and narrowly rounded at the edge. A shallow and somewhat broad radial sulcus from the umbo to the post-ventral border, producing a slight insinuation at the border.

Dimensions—Length 52, height 35, inflation (one valve) 8·5 mm.

Type Locality—Upper Beds, Muddy Creek, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1213A.

Observations—The species occurs rarely in the Miocene only at Camperdown and near Morgan, and has a sparse though wide distribution in the Lower Pliocene of Victoria.

Material—Two topotypes, No. 9863, B.M. Coll., 3 valves Weymouth's Bore, 2 valves Hindmarsh Bore.

Stratigraphical Range—Miocene and Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus Tellina Linné, 1758

Tellina Linné, 1758. Syst. Nat., ed. 10, p. 674.

Type species (s.d. Children, 1823) *Tellina radiata* Linné.

Tellina masoni Tate

Tellina masoni Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 165, pl. 16, fig. 6 a-b.
Tellina masoni Tate. Tate and Dennant, 1893. *id.* 17, (1), p. 225.
Tellina masoni Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 387.
Tellina masoni Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 127.
Tellina masoni Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Tellina masoni Tate. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 94.

Diagnosis—Transversely oblong, rather convex, umbo situated at posterior third. Anterior dorsal margin almost horizontal, anterior margin elongately rounded. Post-dorsal margin oblique, narrowly truncated at posterior. Ventral margin rounded, arched anteriorly and slightly incurved at the umbo-postventral edge. Left valve with a shallow concave depression behind the slight posterior carination.

Dimensions—Length 18, height 11, inflation (both valves) 6 mm.

Type Locality—Lower beds, Muddy Creek, Victoria; Miocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1212A.

Observations—This species was formerly recorded only from the Miocene. It has, however, been found in the Lower Pliocene of Gippsland (Crespin, 1943, p. 94), and in addition to the record of its occurrence from Abattoirs Bore, it is here recorded rather doubtfully from Weymouth's Bore, a single small valve being obtained.

Material—14 valves Abattoirs Bore. Three topotypes, Muddy Creek, Vict., L9865, B.M. Coll.; one left valve, Weymouth's Bore.

Stratigraphical Range—Miocene and Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Tellina albinelloides (Tate)

pl. 5, fig. 12

Tellina albinelloides Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p 164, pl. 16, fig. 4 a-b.
Tellina albinelloides Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 386.
Tellina albinelloides Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 139, 147.

Diagnosis—Inequivalve, umbones subcentral, right valve markedly depressed. Anterior-dorsal slope straight, inclined, anterior margin elongately rounded; posterior side rostrated, broader than anterior, dorsal margin less oblique, edge abruptly truncated. Sculpture of thin, narrow imbricating striae raised into thin, narrow, imbricating lamellae on the angulated posterior slope.

Dimensions—Length 44, height 22, inflation (both valves) 5·5 mm.

Type Locality—Upper Beds, Muddy Creek, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adeliade, T 1211.

Material—Four complete, 2 broken valves, Weymouth's Bore 2 topotypes, B.M. Coll., No. 9864.

Straligraphical Range—Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia,

Genus PSEUDARCOPAGIA Bertin, 1878

Pseudarcopagia Bertin 1878. Nouv. Arch. Mus. His. Nat., Paris, p. 264.

Type species (s.d. Cotton and Godfrey, 1935) *Tellina decussata* Lamarck
= *Pseudarcopagia victoriae* Gatliff and Gabriel

Pseudarcopagia detrita N. H. Woods

pl. 6, fig. 2

Pseudoarcopagia detrita N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, pl. 149; pl. 9, fig. 9 (*lapsus calami* for *Pseudarcopagia*.

Diagnosis—Trigonal, inequilateral, broadly rounded anteriorly, shorter and somewhat truncated posteriorly, ventral margin straight. Sculpture of numerous fine radial striae bifurcating ventrally.

Dimensions—Length 4·8, height 4·2 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1677.

Material—Two right valves, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide District.

Family SEMELIDAE

Genus SEMELE Schumacher, 1817

Semele Schumacher, 1817. Ess. vers. Test. p. 165, pl. 18, fig. 2.
(*Amphidesma* Lamarck, 1818. Anim. s. vert., 5, p. 490.)

Type species (monotypy) *Semele reticulata* Schumacher
= *Tellina proficua* Pulteney

Semele vesiculosa (Tate)

Semele vesiculosa Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 169, pl. 16, fig. 12.
Semele vesiculosa Tate. Tate and Dennant, 1893. *id.* 17, (1), p. 225.
Semele vesiculosa Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., (1), p. 388.
Semele vesiculosa Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 127.
Semele vesiculosa Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Inequilateral, somewhat inflated, anterior side roundly produced, posterior side obtuse-angled. Right valve less convex than left. Post dorsal margin slightly arched, oblique; ventral margin broadly arched anteriorly and medially, slightly insinuated posteriorly.

Dimensions—Length 9, height 6, inflation (both valves) 5 mm.

Type Locality—Lower Beds, Muddy Creek, Victoria; Miocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1199.

Material—Two valves, Hindmarsh Bore 4 topotypes, Muddy Creek, B.M. Coll., Nos. 9862.

Stratigraphical Range—Miocene; Dry Creek Sands.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide, South Australia.

Family DONACIDAE

Genus SOLECURTUS Blainville, 1824

Solecurtus Blainville, 1824. Dict. Sci. Nat., 32, p. 351.

Type species (s.d. Deshayes, 1829) *Solen strigilatus* Linné.

Solecurtus dennanti Tate

Solecurtus dennanti Tate. 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 181, pl. 16, fig. 17.
Solenocurtus dennanti Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 126.
Solecurtus dennanti Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Moderately convex, umbo situated at anterior third; anterior and posterior extremities approximately equally rounded, anterior dorsal margin slightly incurved, post-dorsal margin nearly straight, gently sloping and slightly narrowed towards the posterior margin. Sculpture of concentric growth lines, fine radial striae on the anterior and posterior and oblique distant lines about 1 mm. apart, which are nearly straight in the medial portion of the valve and curve gently to the post-dorsal slope.

Dimensions—Length 29·5, height 12·5 mm.

Type Locality—Lower Beds, Muddy Creek, Victoria; Lower Miocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 342.

Material—Nine fragments, Abattoirs Bore.

Stratigraphical Range—Lower Miocene; Dry Creek Sands.

Geographical Distribution—Port Phillip Bay, Victoria — Adelaide, South Australia.

Solecurtus subrectangularis N. H. Woods

pl. 6, fig. 10

Solecurtus subrectangularis N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 149, pl. 8, fig. 7.

Diagnosis—Small thin, slightly gaping, umbo situated at anterior two-fifths. Posterior side broad, expanded, post-dorsal margin horizontal and parallel to ventral border which is also horizontal; posterior margin truncate-rounded. Anterior narrower, anterior dorsal margin sloping at angle of about 30°, then steeply descending to the ventral border at the anterior margin. Surface sculptured with coarse concentric growth lines and crowded fine radial striae bifurcating towards the ventral margin.

Dimensions—Length 7·7, height 4·6 mm.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1684.

Material—Two excellently preserved right valves, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Hindmarsh Bores, Adelaide.

Superfamily MACTRACEA
Family MACTRIDAE
Genus MACTRA Linné, 1767

Mactra Linné, 1767. Syst. Nat. ed., 12, p. 1,125.

Type species (s.d. Fleming, 1818) *Mactra stultorum* Linné

Subgenus ELECTROMACTRA Iredale, 1930

Electromactra Iredale, 1930. Rec. Aust. Mus., 17, (9), p. 400.

Type species (o.d.) *Mactra parkesiana* Hedley

Mactra (Electromactra) howchiniana Tate

pl. 4, fig. 8

Mactra howchiniana Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 171, pl. 17, fig. 3 a, 3 b.
Mactra howchiniana Tate. Tate and Dennant. *id.* 17, (1), p. 225.
Mactra howchiniana Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 380.
Mactra howchiniana Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 126, 147.
Mactra howchiniana Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Mactra howchiniana Tate. Crespin, 1943. Min. Res. Surv. Bull., 9, p. 93.

Diagnosis—Elongate-ovate, attenuated at both ends, umbo at about three-eighths from anterior; anterior-dorsal margin slightly concave, post-dorsal margin slightly arched, ventral margin almost straight medially, ascending more rapidly posteriorly than anteriorly. Posterior side somewhat produced.

Dimensions—Length 41, height 23, inflation (both valves) 12 mm.

Type Locality—Lower Beds, Muddy Creek, Victoria; Miocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1195.

Observations—Tate (1887b, p. 171) has noted that large numbers of young shells of this species are not uncommon in the calciferous sand-rock of the River Murray cliffs near Morgan. This may also be said of certain borings in the Adelaide District. In both Abattoirs and Hindmarsh Bores, very many juvenile examples were recovered, although in Weymouth's Bore not one valve was found. In other borings with a less numerous molluscan fauna, the species appears in small numbers, but with relative constancy. The species is long-ranging and widely occurring; in the Gippsland area it has been recorded from the "Mitchellian" and "Kalimnan" only.

Material—Two specimens Lower Beds, Muddy Creek, L.9880, B.M. Coll., numerous specimens Hindmarsh and Abattoirs Bores.

Stratigraphical Range—Lower Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Genus ANAPELLA Dall, 1895

Anapella Dall, 1895. Proc. Mal. Soc. Lond., 1, (5), p. 213.

Type species (o.d.) *Anapa triquetra* Hanley

Anapella variabilis Tate

Anapa variabilis Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 172, pl. 17, fig. 5 a-b.
Anapella variabilis Tate, Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 139.
Anapella variabilis Tate. Cotton, 1947. Rec. S. Aust. Mus., 8, (4), p. 655.

Diagnosis—Ovately trigonal, inequilateral, posterior side longer, bluntly rounded, anterior side rounded, front dorsal slope slightly incurved.

Dimensions—Length 17·5, height 13·5, inflation (both valves) 11 mm.

Type Locality—Oyster Banks, Blanche Point, Aldinga Bay, South Australia; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1209.

Material—Two valves, Holden's Bore, 355-380 feet.

Stratigraphical Range—South Australian Pliocene.

Geographical Distribution—Aldinga Bay and Adelaide, South Australia.

Genus ZENATIOPSIS Tate, 1879

Zenatiopsis Tate, 1879. Trans. Phil. Soc. Adel. for 1878/9, p. 129.

Type species (monotypy) *Zenatiopsis angustata* Tate

Zenatiopsis angustata Tate

Zenatiopsis angustata Tate, 1879. Trans. Phil. Soc. Adel. for 1878/9, p. 129, pl. 5, fig. 6.
Zenatiopsis angustata Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 172.
Zenatiopsis angustata Tate. Harris, 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 381.
Zenatiopsis angustata Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 126, 139, 147.
Zenatiopsis angustata Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.

Diagnosis—Compressed, narrowly oblong, anterior side very short, rounded; posterior side long, rounded. Umbo anterior, supported internally by a thick rib extending half way across the valve; narrowly gaping at both ends; cartilege plate prominent, cardinal teeth distinct. Lateral teeth absent. Sculpture of fine growth plications and numerous crowded fine striae.

Dimensions—Length 46, height 18, length of anterior side 6 mm.

Type Locality—Upper Beds, River Murray Cliffs, near Morgan; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ of Adelaide, T 1205.

Material—Portions of three valves, Weymouth's Bore.

Stratigraphical Range—Miocene to Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Suborder ASTHENODONTA

Superfamily MYACEA

Family CORBULIDAE

Genus Corbula Bruguière, 1797

Corbula Bruguière, 1797. Ency. Meth. vers., 2, pl. 230.
(*Aloidis* Megerle, 1811. Ges. Naturf., Berlin, Mag., 5, p. 67.)
(*Notocorbula* Iredale, 1930. Rec. Aust. Mus., 17, p. 404.)

Type species (s.d. Schmidt, 1818) *Corbula sulcata* Lamarck

Corbula ephamilla Tate

pl. 4, fig. 4, 5, 6, 7

Corbula sulcata Lamarck. McCoy, 1865. Ann. Mag. Nat. Hist., ser. 3, 16, p. 114.
Corbula sulcata Lamarck. Tenison-Woods, 1876. Pap. Roy. Soc. of Tas. for 1875, p. 16.
Corbula sulcata Lamarck. Etheridge, R., Jr., 1878. Cat. Aust. Ross., p. 154.
Corbula ephamilla Tate, 1885. Proc. Roy. Soc. Tas. for 1884, p. 229.
Corbula ephamilla Tate, 1887 b. Trans. Roy. Soc. S. Aust., 9, p. 176, pl. 17, fig. 13 a-b, 14.
Corbula ephamilla Tate. Tate and Dennant. id. 17, (1), p. 225.
Corbula ephamilla Tate. Pritchard, 1896. Proc. Roy. Soc. Vict., 8, (n.s.), p. 140.
Corbula ephamilla Tate. Harris 1897. Cat. Tert. Moll. Brit. Mus., 1, p. 382.
Corbula ephamilla Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., 1, (2), p. 126, 139, 147.
Corbula ephamilla Tate. N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 181.
Aloidis (Notocorbula) ephamilla (Tate). Crespin, 1943. Min. Res. Surv. Bull., 9, p. 91.

Diagnosis—Solid, very inequivalve; posterior margin obliquely truncated, right valve with more than 20 very thick, rounded prominent concentric ridges, ridges and interspaces with numerous fine, somewhat irregular concentric striae. Left valve ovately triangular, nearly flat, pointed posteriorly, surface with irregular growth striae. Shells easily decorticated, surface after decortication smooth with only faint ridges.

Dimensions—Length 21, height 16, inflation (both valves) 10 mm.

Type Locality—River Murray Cliffs, Morgan, South Australia; Miocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T. 335.

Observations—The name *Corbula* was first published in 1797 by Bruguière at the head of plate 230 of the Ency. Meth., figuring several species of the genus, without specific names or generic description. Röding published the name in 1798 for a genus determined by both Winckworth (March, 1930, p. 15) and Iredale (June 1930 p. 404) as a synonym of *Asaphis* Modeer, 1793. Lamarck diagnosed *Corbula* of Bruguière in 1799 (p. 8), the type species *C. sulcata* being designated by Schmidt (1818, p. 17) and later by Gray (1847, p. 191). Under earlier

determinations of the International Rules of Zoological Nomenclature Bruguière's genus was invalid, although the name was accompanied by sufficient figures to make the import obvious. Lamarck's name then became a homonym of *Corbula* Röding, and the next available name was *Aloidis* of Megerle. *Aloidis* has been accepted and employed by several authors on these grounds, but by a recent amendment of the International Rules a genus is valid if introduced with an indication, and *Corbula* Bruguière is acceptable under this amendment.

Material—Twelve valves, Weymouth's Bore; 11 valves including the hypotypes figured pl. 4, figs. 4, 5, 7; 22 valves Lower Beds, Muddy Creek, and 8 valves Lower and Upper Beds, Muddy Creek, B.M. Coll.

Stratigraphical Range—Miocene to Upper Pliocene.

Geographical Distribution—Gippsland, Victoria — Adelaide, South Australia.

Corbula adelaidensis nom. nov.

pl. 6, fig. 11

Corbula equivalis N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 150, pl. 8, fig. 8, 9 (non Philippi, 1836).

Diagnosis—Elongate-ovate, nearly twice as long as high, equivalve; umbo at anterior third. Posterior side produced, weakly keeled. Surface sculptured with fine irregular concentric striae.

Dimensions—Length 14·2, height 9·3.

Type Locality—Abattoirs Bore, Adelaide; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T. 1682.

Observations—The Recent *Corbula flindersi* (Cotton) is very close to this species, which is, however, more equivalve and more strongly sculptured. The species known as *Corbula coxi* Pilsbry identified from the Kalimnan of Victoria (and not *C. coxi*) is the nearest fossil ally. The name *equivalvis* N. H. Woods is a homonym of *equivalvis* employed by Philippi for a Cuban shell.

Material—Two valves, Weymouth's Bore; 1 complete specimen, 30 valves and several portions of valves, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Family HIATELLIDAE

Genus Hiatella Daudin, 1801

Hiatella Daudin, 1801, in Bosc., Hist. Nat. des Coq., **3**, p. 120.
(*Saxicava* Bellevue, 1802. Journ. Phys., **54**, p. 5.)

Type species (s.d. Children 1823) *Mya arctica* Linné.

Hiatella australis (Lamarck)

pl. 5, fig. 10

Corbula australis Lamarck, 1818, Anim. s. Vert., **5**, p. 495.
Saxicava australis Lamarck, ibid, p. 502.
Saxicava veneriformis, ibid, p. 502.
Corbula australis Lamarck, Blainville, 1825, Man. de Malac., p. 561, pl. 78, fig. 3.
Corbula australis Lamarck 1835, Anim s. vert. (ed. 2 Deshayes and Edwards), **6**, p. 138, No. 1.
Saxicava australis Lamarck, Reeve, 1875. Conch. Icon., **20**, pl. 2, fig. 8.
Saxicava australis Lamarck. Hutton, 1880. Man. N.Z. Moll., p. 134.
Saxicava australis Lamarck. Tate, 1886. Trans. Roy. Soc. S. Aust., **8**, pl. 12, fig. 8.
Saxicava arctica Linné. Tate, 1887, *id*, **9**, p. 178.
Saxicava arctica Linné Dennant and Kitson, 1903. Rec. Geol. Surv. Vict., **1**, (2), p. 126, 139, 147.
Saxicava australis Lamarck, N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., **55**, p. 151.
Hiatella australis Lamarck, Cotton and Godfrey, 1938. Moll., S. Aust., p. 284.

Diagnosis—Usually ovate-oblong, very inequilateral, rugose, posterior side longer, sculpture of irregular, concentric raised, often anastomosing riblets, crowded anteriorly, distant and rather lamellar posteriorly.

Dimensions—Very variable, an average South Australian example measures length 37, height 26, inflation 22 mm.

Type Locality—King George Sound, W. Aust.; Recent.

Location of Holotype—Mus. Hist. nat. Paris.

Observations—As a footnote to 6, p. 138, of the 1835 edition of Lamarck's Anim. s. Vert. Deshayes and Edwards have explained that the shell described by Lamarck is not a *Corbula* but a *Saxicava*, Lamarck having failed to notice that the ligament is external, the valves are gaping, irregular, unequal and that the hinge has a projecting tooth characteristic of most of the *Saxicavas*. As a footnote to p. 153, Deshayes and Edwards have expressed the view that *Corbula australis, Saxicava australis*, and *S. veneriformis* are one and the same species; as they remark, "such diverse forms deceive the most talented observers, particularly when they have examined only a small number of individuals. The three species should be united." Hanley disagreed (1843, p. 51) with this view on the evidence of Blainville's figures, but as Deshayes and Edwards had presumably seen the actual specimens, authors have followed their opinion, and the specimen originally described as *Corbula australis* is accepted as type.

Material—Three valves, Hindmarsh Bore.

Stratigraphical Range—Miocene to Recent.

Geographical Distribution—Australia, New Zealand, America.

Hiatella angasi (Angas)

pl. 5, fig. 13, 14

Saxicava angasi Angas ex Adams, 1865. Proc. Zool. Soc., p. 643.
Saxicava angasii Adams. Sowerby, 1878. Conch. Icon., 20, pl. 2, fig. 11.
Saxicava subalata N. H. Woods, 1931. Trans. Roy. Soc. S. Aust., 55, p. 151.
Hiatella angasi Adams. Cotton and Godfrey, 1938. Moll. S. Aust.

Diagnosis—Irregularly rhomboidal, anterior side very short, anterior dorsal edge steeply sloping to the rounded ventral edge. Post-dorsal margin straight, posterior side oblong, inflated, gaping, rectangular on posterior edge.

Dimensions—Length 53·5, height 35·5, inflation (both valves), 25 mm.

Type Locality—Oyster banks, Port Lincoln, South Australia, living in sandy mud at from 5 to 8 fathoms; Recent.

Location of Holotype—British Museum (Natural History).

Observations—The small species occurring in the Dry Creek Sands was previously identified by the writer with the Victorian *subalata* Gatliff and Gabriel. Comparison with authentic specimens of *subalata* and with the holotype of *angasi* leads to the opinion that the fossil shells are small examples of *angasi*. They are thicker, stouter, more gaping, less regular than, and lack the granulation characteristic of *subalata*.

Material—Holotype; 2 complete valves, one portion, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—St. Vincent Gulf, South Australia.

Suspense List

The following species have been recorded by Cotton from the Dry Creek Sands. As the material cannot now be traced, they are not included in the foregoing list, particularly as in one or two cases there are several species which closely resemble one another and confusion is possible.

Glycymeris (Veletuceta) subradians Basedow.

Amusium lucens (Tate).

Lithophaga brevis (Tate), pl. 6, fig. 13. As the holotype has never been figured, opportunity is taken here of doing so.

Gonimyrtea araea (Tate). The holotype of this species has wholly disintegrated, and identification is impossible.

Loripes simulans Tate.
"Kellia" planiuscula Tate.
Bassina paucirugata (Tate).
Plebidonax depressa (Tate).

Brachidontes submenkeanus (Tate)

pl. 6, fig. 12

Mytilus submenkeanus Tate. 1886. Trans. Roy. Soc. S. Aust., **8**, p. 124.
Mytilus submenkeanus Tate. Dennant and Kitson, 1903. Rec. Geol. Surv. Vict, **1**, (2), p. 139.
Brachyodontes submenkeana Tate. Cotton, 1947. Rec. S. Aust. Mus., **8**, (4), p. 655.

Diagnosis—Sculptured with about eight broad, longitudinal ribs.

Description of Syntypes—Shell subtrigonal, probably narrow, umbonal-ventral ridge smooth, posterior to ridge without longitudinal ribs and sculptured only with growth folds. From ridge to anterior border about eight radiating broad longitudinal ribs which appear to be slightly tuberculated by the growth folds towards the ventral border.

Dimensions (estimated from syntypes)—Height 35 mm., width 10 mm.

Type Locality—Hallett Cove; Pliocene.

Location of Syntypes—Tate Mus. Coll., Univ. of Adelaide, T 994.

Observations—This species has never been fully described or figured. Material available for description is still very poor, but opportunity is here taken of describing the syntypes and of figuring them.

Material—Three syntypes.

Stratigraphical Range—Pliocene.

Geographical Distribution—Hallett Cove, South Australia.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. *Nucula (Ennucula) kalimnae* Singleton. Weymouth's Bore, left valve, external view, x 2·6.

Fig. 2. *Nucula (Ennucula) kalimnae* Singleton. Weymouth's Bore, left valve, internal view, x 2·6.

Fig. 3. Nucula (*Ennucula*) *beachportensis* Verco. Hindmarsh Bore, left valve, external view, x 8·6.

Fig. 4. *Nucula (Ennucula) beachportensis* Verco. Hindmarsh Bore, left valve, internal view, x 8·6.

Fig. 5. *Nuculana woodsi* (Tate). Hindmarsh Bore, right valve, x 4·3.

Fig. 6. *Nuculana crebrecostata* T. Woods. Abattoirs Bore, left valve, x 3·4.

Fig. 7. *Nuculana verconis* Tate. Abattoirs Bore, right valve, x 3·4.

Fig. 8. *Cucullaea corioensis* McCoy. Weymouth's Bore, juvenile, left valve, x 8·6.

Fig. 9. *Cucullaea corioensis* McCoy. Weymouth's Bore, adult, left valve, x 1·4.

Fig. 10. *Limopsis maccoyi* Chapman. Tennant's Bore, right valve, x 1·7.

Fig. 11. *Limopsis eucosmus* Verco. Weymouth's Bore, right valve, x 8·6.

Fig. 12. *Limopsis vixornata* Verco. Weymouth's Bore, left valve, x 7.

Fig. 13. *Lentipecten adelaidensis* sp. nov. Abattoirs Bore: a, holotype x 1·7; b, parasyntype, right valve, x 0·9; c, parasyntype, left valve, x 0·9.

Fig. 14. *Lissarca rubricata* (Tate). Hindmarsh Bore, right valve, x 7.

Fig. 15. *Cuna polita* (Tate). Hindmarsh Bore, right valve, x 8·6.

Fig. 16. *Lissarca rhomboidalis* Verco. Hindmarsh Bore, right valve, x 8·6.

Fig. 17. *Myadora corrugata* Tate. Weymouth's Bore, left valve, x 3·4.

Fig. 18. *Condylocardia tenuicostae* Chapman and Gabriel. Hindmarsh Bore, left valve, external view, x 8·6.

Fig. 19. *Condylocardia tenuicostae* Chapman and Gabriel. Hindmarsh Bore, left valve, internal view, x 8·6.

Fig. 20. *Sportella jubata* Hedley. Hindmarsh Bore, left valve, x 3; hinge x 3·4.

PLATE II

Fig. 1. *Spondylus spondyloides* Tate. Weymouth's Bore, x 1·4; left hinge, x 1·4.

Fig. 2. *Cardita compta* (Tate). Weymouth's Bore, right valve, x 1·7.

Fig. 3. *Pleuromeris subpecten* sp. nov., holotype, x 4·3.

Fig. 4. *Pleuromeris trigonalis* (Tate). Weymouth's Bore, x 3·4; hinge, x 4·3.

Fig. 5. *Cyclocardia (Scalaricardita) subcompacta* (Chapman and Crespin). Weymouth's Bore, x 3·4; hinge, x 5·1.

Fig. 6. *Glans dennanti* (Chapman and Crespin). Weymouth's Bore, x 1·4.

Fig. 7. *Cyclocardia (Arcturellina) peridonea* sp. nov., holotype. Hindmarsh Bore, x 3; hinge, x 4·3.

Fig. 8. *Cyclocardia (Scalaricardita) subcompacta* (Chapman and Crespin), juvenile. Weymouth's Bore, x 7; hinge, x 8·6.

Fig. 9. *Cyclocardia (Arcturellina) hindmarshensis* sp. nov., holotype. Hindmarsh Bore, x 3; hinge, x 4·3.

Fig. 10. *Callucina balcombica* (Cossmann). Weymouth's Bore, right valve, internal and external views, x 1·7; left hinge, x 3·4.

Fig. 11. *Eomiltha (Gibbolucina) confirmans* sp. nov., holotype. Hindmarsh Bore, x 2·6; hinge, x 3·4.

Fig. 12. *Gonimyrtea salisburyensis* sp. nov., holotype. Abattoirs Bore, external and internal views, x 1·7; right hinge, x 2·6.

Fig. 13. *Monitilora (Prophetilora) chavani* sp. nov., holotype. Abattoirs Bore, x 1·7; left hinge, x 2·6; right hinge, x 1·7.

Fig. 14. *Linga (Bellucina) nuciformis* (Tate). Abattoirs Bore, right valve, x 2·1.

Fig. 15. *Linga (Bellucina) nuciformis* (Tate). Abattoirs Bore, internal view, x 2·1; left hinge, x 2·6.

Fig. 16. *Myrtea fabuloides* (Tate). Abattoirs Bore, right valve, x 2·6; left hinge, x 2·6; right hinge, 2·6.

Plate III

Fig. 1. *Monitilora idonea* sp. nov. Hindmarsh Bore, holotype, exterior view, x 2·1.
Fig. 2. *Monitilora idonea* sp. nov. Hindmarsh Bore, holotype, interior view, x 1·7.
Fig. 3. *Gonimyrtea crassior* sp. nov. Weymouth's Bore, holotype, x 2·6; hinge, x 3·4
Fig. 4. *Gonimyrtea crassior* sp. nov., paratype. Hindmarsh Bore, x 3.
Fig. 5. *Gonimyrtea validior* sp. nov., holotype. Hindmarsh Bore, external view, x 2·6; hinge, paratype, x 2·6.
Fig. 6. *Gonimyrtea validior* sp. nov., holotype. Hindmarsh Bore, internal view, x 2·6.
Fig. 7. *Gonimyrtea notabilior* sp. nov., holotype. Hindmarsh Bore, external view, x 2·6; hinge, x 2·6.
Fig. 8. *Gonimyrtea notabilior* sp. nov., paratype, internal view, x 2·6.
Fig. 9. *Divalucina cumingi* (Adams and Angas). Weymouth's Bore, x 1·4.
Fig. 10. *Bornia trigonale* (Tate). Hindmarsh Bore, left valve, x 8·6; hinge, 8·6.
Fig. 11. *Lutigiella adelaidensis* sp. nov., holotype. Hindmarsh Bore, x 6.
Fig. 12. *Myllita hindmarshensis* sp. nov., holotype. Hindmarsh Bore, x 8·6; hinge, x 12.
Fig. 13. *Properycina torrensensis* sp. nov., holotype. Hindmarsh Bore, x 6; right hinge (on left), left hinge (on right), x 6.
Fig. 14. *Mysella anomala* Angas. Abattoirs Bore, right valve, x 3·4; hinge, x 4·3.
Fig. 15. *Montacuta sericea* Tate. Hindmarsh Bore, right valve, x 3; hinge, x 4.
Fig. 16. *Nemocardium (Pratulum) proterothetidis* sp. nov., holotype. Abattoirs Bore, x 3·4.
Fig. 17. *Nemocardium (Pratulum) proterothetidis* sp. nov., holotype. Abattoirs Bore, internal view, x 3·4.
Fig. 18. *Tawera incurvilamellata* sp. nov., holotype. Abattoirs Bore, external view, x 2·6.
Fig. 19. *Tawera incurvilamellata* sp. nov., holotype. Abattoirs Bore, internal view, x 2·6.
Fig. 20. *Tawera gallinula* Lamarck. Abattoirs Bore, right valve, x 2·6; hinge, x 2·6.

Plate IV

Fig. 1. *Glans spinulosa* (Tate). Abattoirs Bore, x 1·4.
Fig. 2. *Placamen subroborata* (Tate). Muddy Creek, Victoria, left valve, x 1·4.
Fig. 3. *Placamen subroborata* (Tate). Weymouth's Bore, juvenile, right valve, x 2·6.
Fig. 4. *Corbula ephamilla* Tate. Hindmarsh Bore, right valve, external view, x 1·7.
Fig. 5. *Corbula ephamilla* Tate. Hindmarsh Bore, right valve, internal view, x 1·7.
Fig. 6. *Corbula ephamilla* Tate. Abattoirs Bore, both valves, x 2·1.
Fig. 7. *Corbula ephamilla* Tate. Hindmarsh Bore, left valve, x 2·1.
Fig. 8. *Mactra (Electromactra) howchiniana* Tate. Hindmarsh Bore, x 1·7.
Fig. 9. *Macoma ralphi* (Finlay). Weymouth's Bore, left valve, external view, x 1·7.
Fig. 10. *Macoma ralphi* (Finlay). Weymouth's Bore, left valve, internal view, x 1·7.
Fig. 11. *Anomia tatei* Chapman and Singleton. Abattoirs Bore, x 0·85.
Fig. 12. *Vasticardium (Regozara) praecygnorum* sp. nov., holotype. Dry Creek Bore, right valve, x 1·7.
Fig. 13. *Fulvia tenuicostata* (Lamarck). Dry Creek Bore, right valve, x 1·7.
Fig. 14. *Cardita subdeceptiva* sp. nov., holotype. Dry Creek Bore, x 0·85.
Fig. 15. *Brachidontes hirsutus* (Lamarck). Abattoirs Bore, left valve, juvenile, x 2·6.
Fig. 16. *Chlamys (Chlamys) polyaktinos* sp. nov., holotype. Abattoirs Bore, x 1·7.
Fig. 17. *Gari hamiltonensis* (Tate). Abattoirs Bore, juvenile, x 3·4.
Fig. 18. *Vasticardium submaculosum* sp. nov., holotype. Weymouth's Bore, x 1·7.
Fig. 19. *Chioneryx dennanti* (Chapman and Crespin). Weymouth's Bore, x 1·7.

Plate V

Fig. 1. *Ostrea (Lopha) hyotidoidea* Tate. Abattoirs Bore, x 0·85.
Fig. 2. *Notocallista (Striacallista) mollesta* Marwick. Abattoirs Bore, x 0·85.
Fig. 3. *Notocallista (Striacallista) pestis* Marwick. Weymouth's Bore, x 2·1.
Fig. 4. *Eucrassatella camura* (Pritchard). Kooyonga Bore, x 0·85.
Fig. 5. *Dosina (Hina) cainozoica* Tenison-Woods. Weymouth's Bore, x 1·4.

Fig. 6. *Eucrassatella kingicoloides* (Pritchard). Kooyonga Bore, x 0·85.
Fig. 7. *Limopsis beaumariensis* Chapman. Abattoirs Bore, x 1·4.
Fig. 8. *Chlamys (Mesopeplum) incerta* Tenison-Woods. Weymouth's Bore, right valve, x 1·7.
Fig. 9. *Chlamys (Mesopeplum) incerta* Tenison-Woods. Weymouth's Bore, left valve, x 1·7.
Fig. 10. *Hiatella australis* (Lamarck). Hindmarsh Bore, x 3·7.
Fig. 11. *Chlamys (Chlamys) antiaustralis* Tate. Kooyonga Bore, x 0·85.
Fig. 12. *Tellina albinelloides* Tate. Immature specimen, Weymouth's Bore, x 1·7; hinge, x 2·6.
Fig. 13. *Hiatella angasi* (Angas). Hindmarsh Bore, internal view, x 4.
Fig. 14. *Hiatella angasi* (Angas). Hindmarsh Bore, external view, x 3·7.
Fig. 15. *Cucullaea praelonga* Singleton. Kooyonga Bore, x 0·85

PLATE VI

Fig. 1. *Nucula venusta* N. H. Woods. Holotype. Abattoirs Bore, x 4·3.
Fig. 2. *Pseudarcopagia detrita* N. H. Woods. Holotype. Abattoirs Bore, x 4·3.
Fig. 3. *Eomiltha (Gibbolucina) salebrosa* (N. H. Woods). Holotype. Abattoirs Bore, x 0·85.
Fig. 4. *Diplodonta solitaria* N. H. Woods. Holotype. Abattoirs Bore, x 1·1.
Fig. 5. *Tawera pernitida* (N. H. Woods). Abattoirs Bore, x 2·1.
Fig. 6. *Thyasira sinuata* (N. H. Woods). Holotype. Abattoirs Bore, x 2·2.
Fig. 7. *Mysella tellinoides* (N. H. Woods). Holotype. Abattoirs Bore, x 5·1.
Fig. 8. *Mysella macer* (N. H. Woods). Holotype. Abattoirs Bore, x 2·6.
Fig. 9. *Gafrarium perornatum* N. H. Woods. Holotype. Abattoirs Bore, x 2·6.
Fig. 10. *Solecurtus subrectangularis* N. H. Woods. Holotype. Abattoirs Bore, x 3.
Fig. 11. *Corbula adelaidensis* nom. nov. Holotype. Abattoirs Bore, x 1·7.
Fig. 12. *Brachidontes submenkeanus* (Tate). Syntypes. Hallett Cove, x 0·85
Fig. 13. *Lithophaga brevis* (Tate). Holotype. Hallett Cove, x 1·4.
Fig. 14. *Lima bassi* Tenison-Woods. Abattoirs Bore, x 2·6.
Fig. 15. *Properycina micans* (Tate). Hinge, x 8·6.

PLATE I

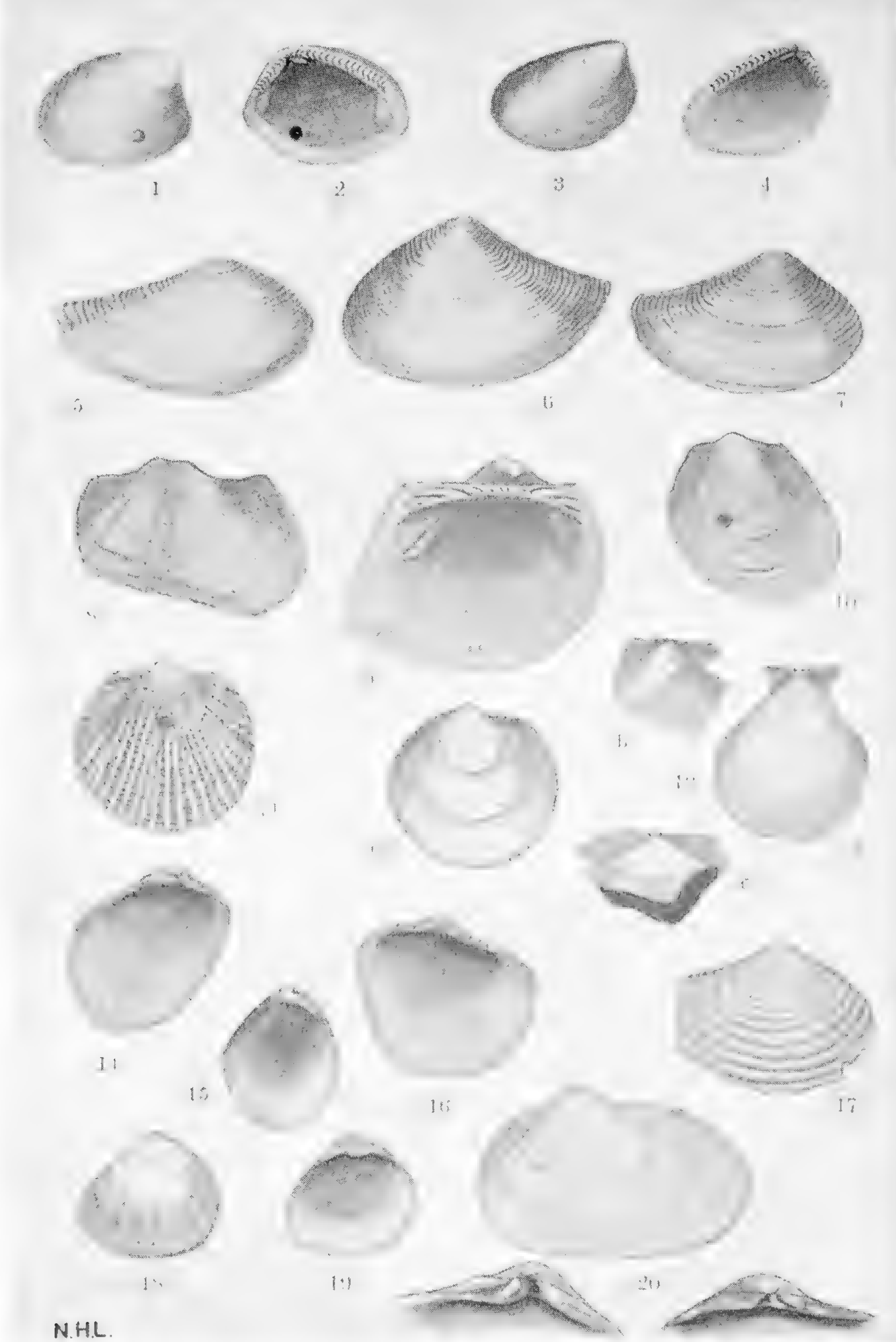


PLATE 2
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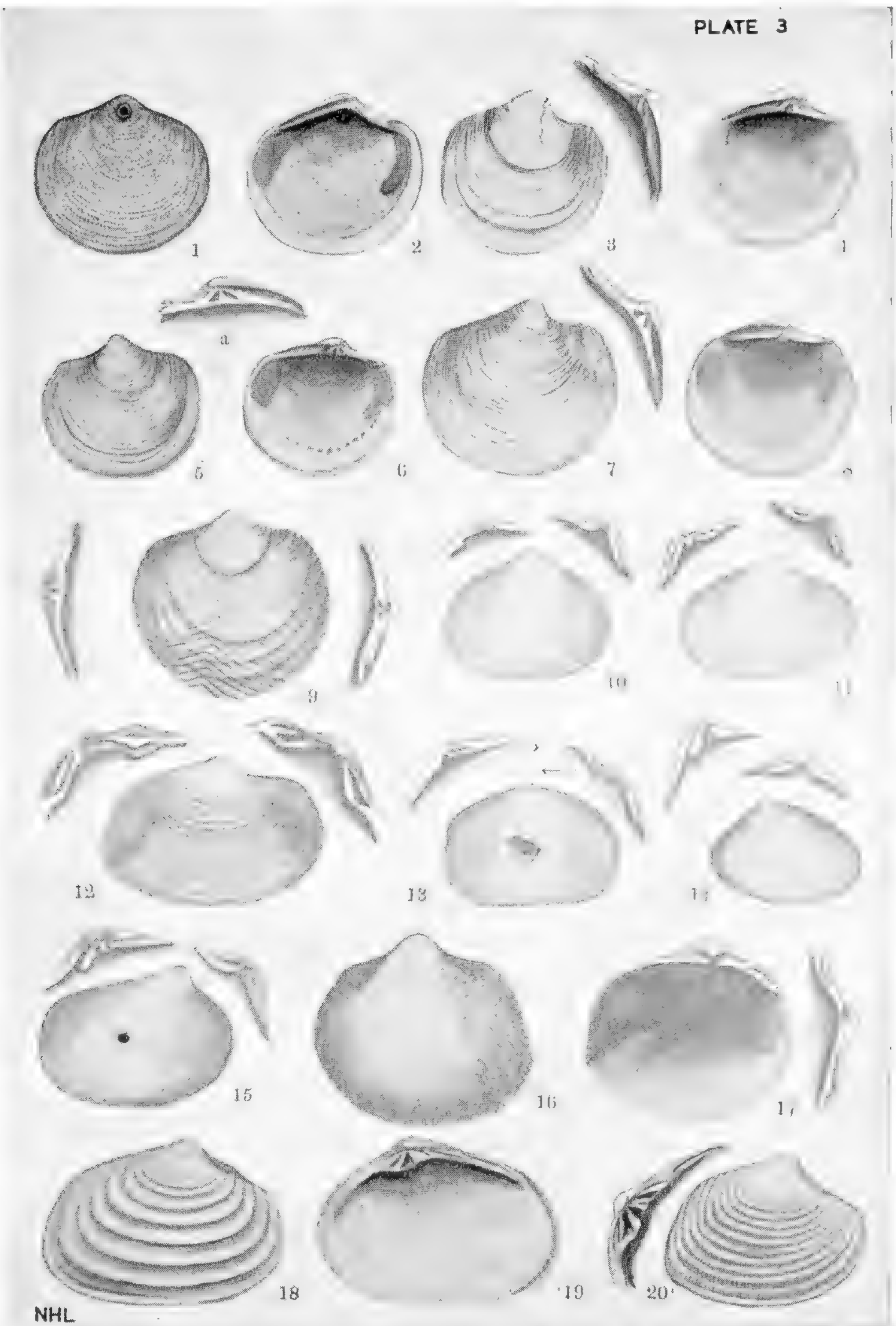
PLATE 3
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PLATE 4
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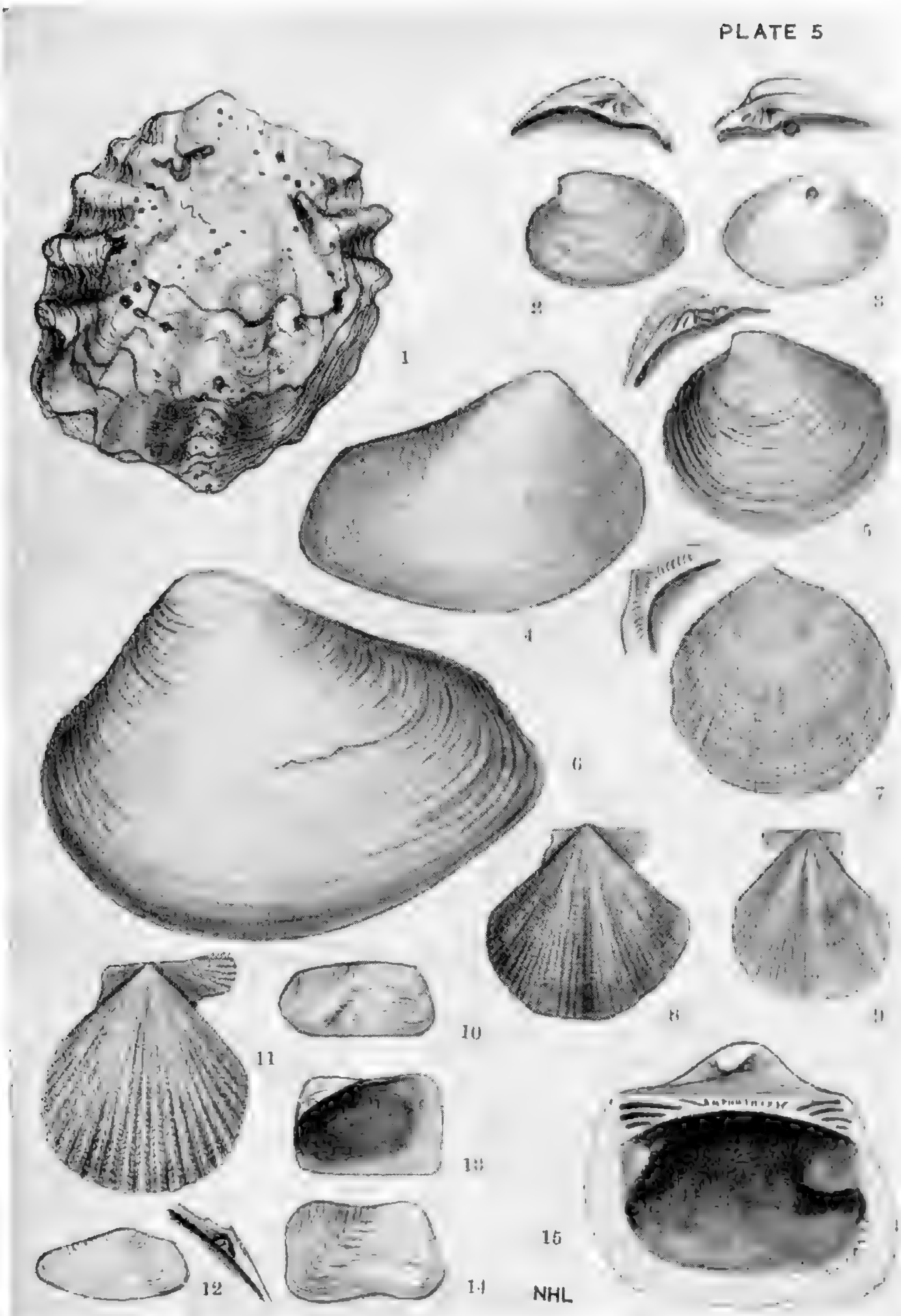


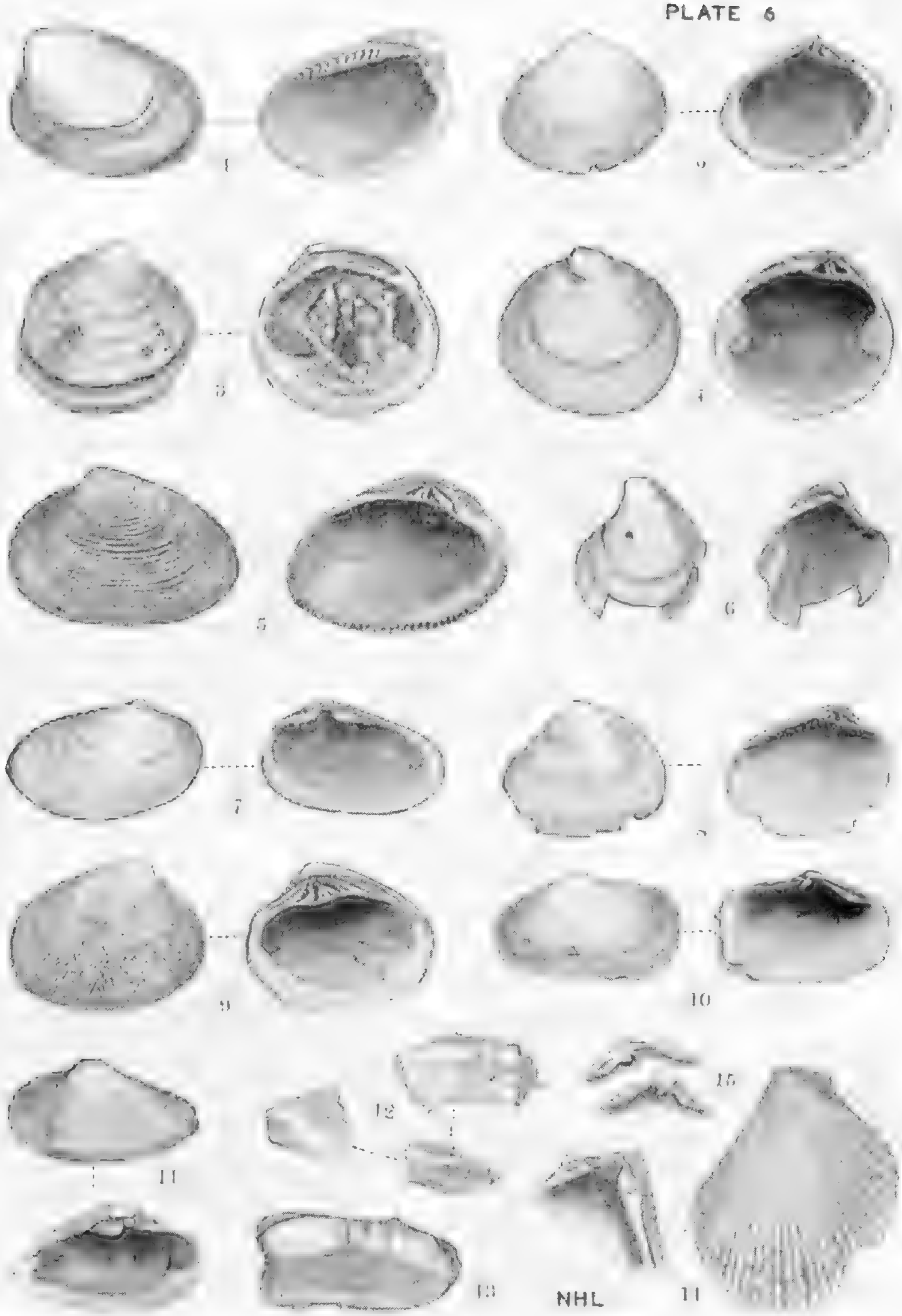


PLATE 6
NHL

AUSTRALITES PART VI
SOME NOTES ON UNUSUALLY LARGE AUSTRALITES

*BY CHARLES FENNER**

Summary

Maps showing world distribution of tektites, and the distribution of australites in Australia as at 1954 have been prepared, together with a schedule briefly describing some particularly large australites.

AUSTRALITES PART VI
SOME NOTES ON UNUSUALLY LARGE AUSTRALITES

By CHARLES FENNER *

[Read 8 April 1954]

SUMMARY

Maps showing world distribution of tektites, and the distribution of australites in Australia as at 1954 have been prepared, together with a schedule briefly describing some particularly large australites.

INTRODUCTION

From time to time, among the objects that have fallen on the earth, various puzzling glassy blobs known generally as tektites have been found. The earliest recorded are the Moldavites from along the Moldau River in Czechoslovakia, an analysis of which was published by Dufreney in 1847. During the subsequent century many swarms of these siliceous objects have been discovered and an extensive literature has been built up. Many tektites must have fallen in the oceans and some marginal to continents. Those peculiar to Australia are known as Australites, thousands of which have been handled, measured, and classified by the writer. For this paper a schedule of some particularly large Australites has been prepared and some of them illustrated. The map, fig. 1, shows the world-wide distribution of tektites and pseudotektites roughly in order of discovery.

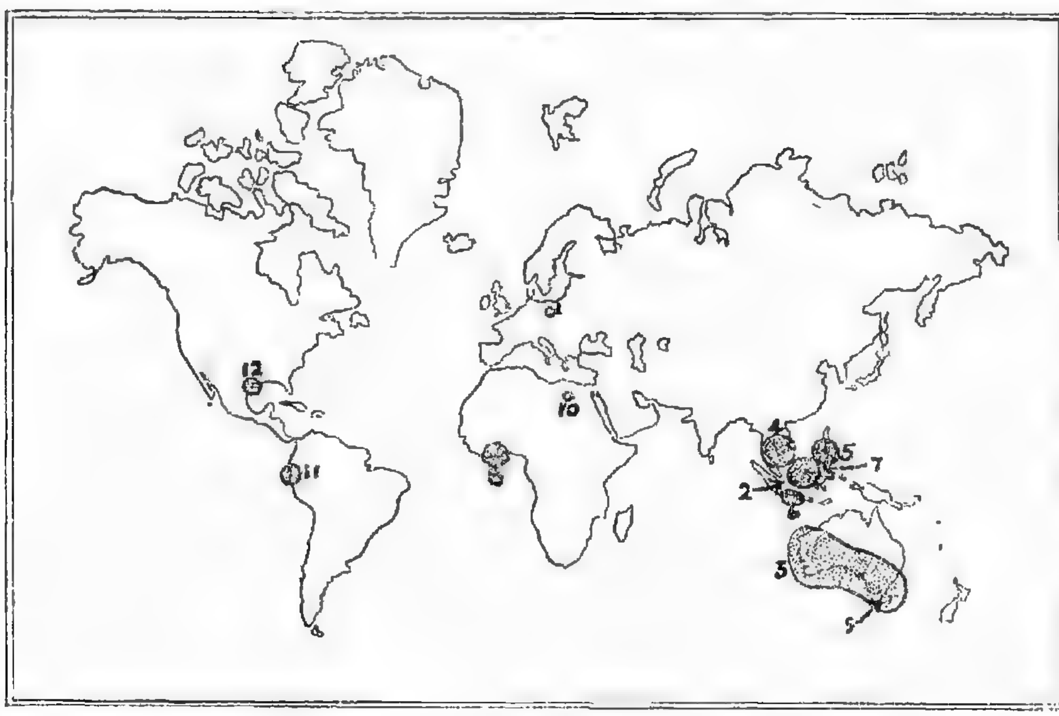


Fig. 1
Mercator's Projection, showing World Distribution of Tektites.

* Geologist, South Australian Museum, Hon. Research Fellow, Institute of Meteoritics, University of New Mexico, New Mexico, U.S.A.

1. Moldavites from the River Moldau, Czechoslovakia.
2, Billitonites from the Island of Billiton, Indonesia.
3. Australites, over the southern half of Australia.
5. Rizalites from the Rizal Province in the Philippines.
4. Indochinites from Indochina.
6. Javanites from Java, Indonesia.
7. Borneoites from Borneo and adjacent islands.
2. Tektites from the Ivory Coast, West Africa.
9. Darwin Glass, from Mount Darwin, Tasmania.
10. Libyan Glass, from Libya, North Africa.
11. Tektites from Colombia, South America.
12. Bediasites from Grimes County, Texas, U.S.A.

Fig. 2 shows the distribution of Australites as at 1954.

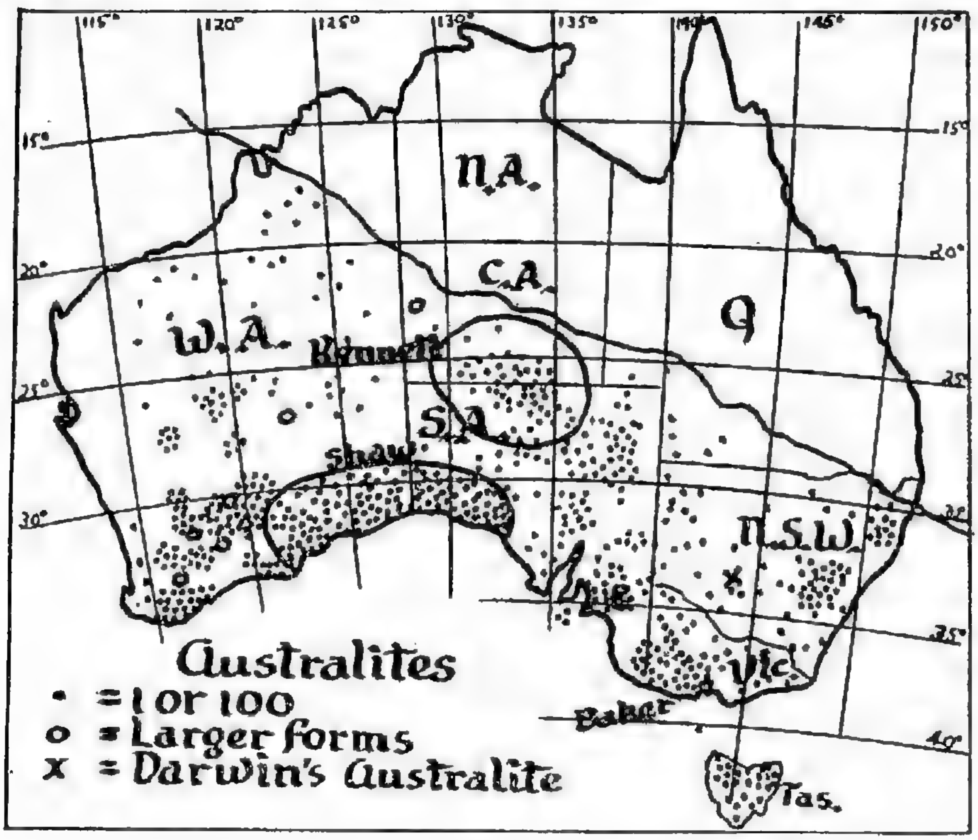


Fig. 2

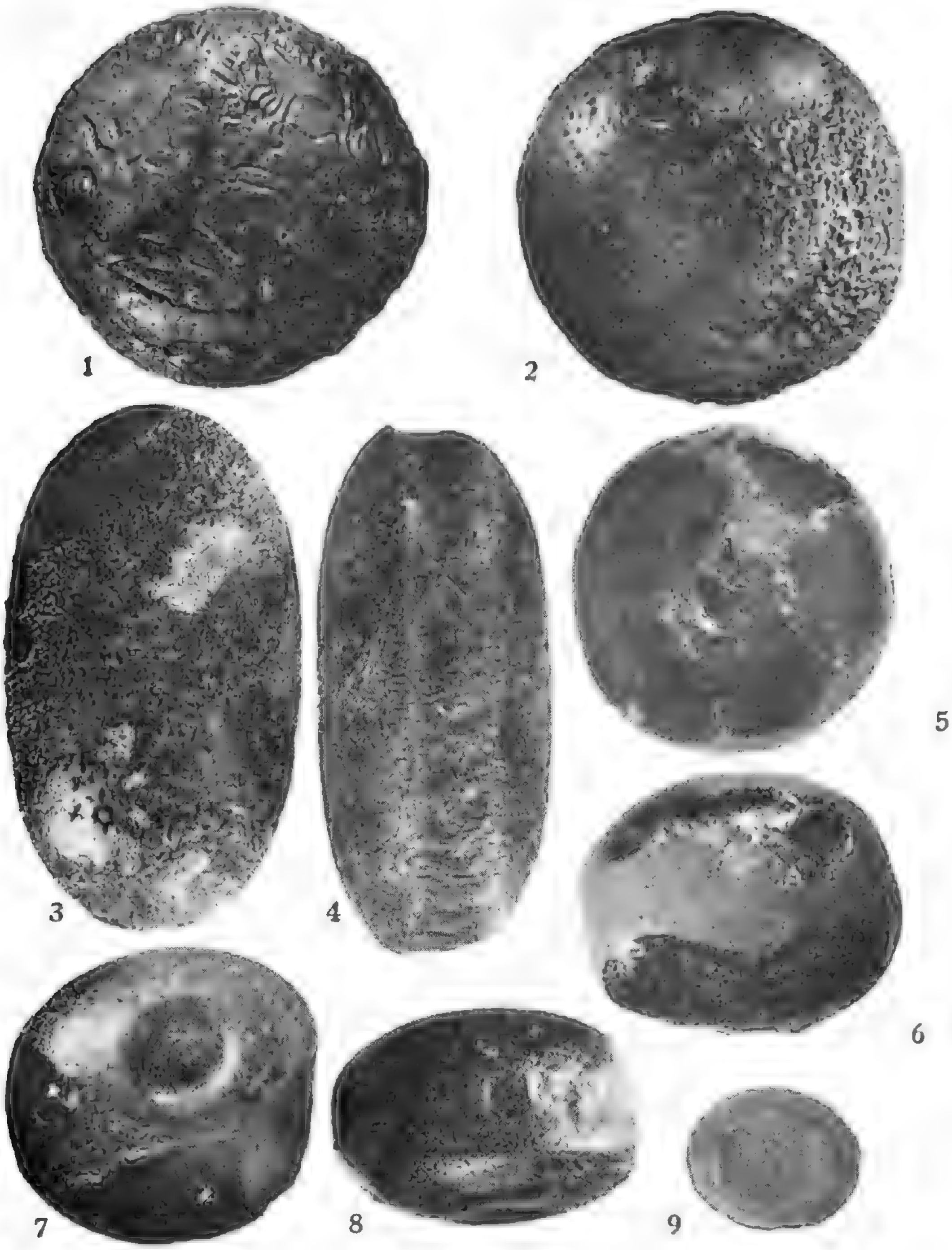
Map of Australia, showing the known strewnfield of the Australites as at 1954. The areas of some of the chief large collections (Shaw, Kennett and Baker) are outlined.

LARGE AUSTRALITES

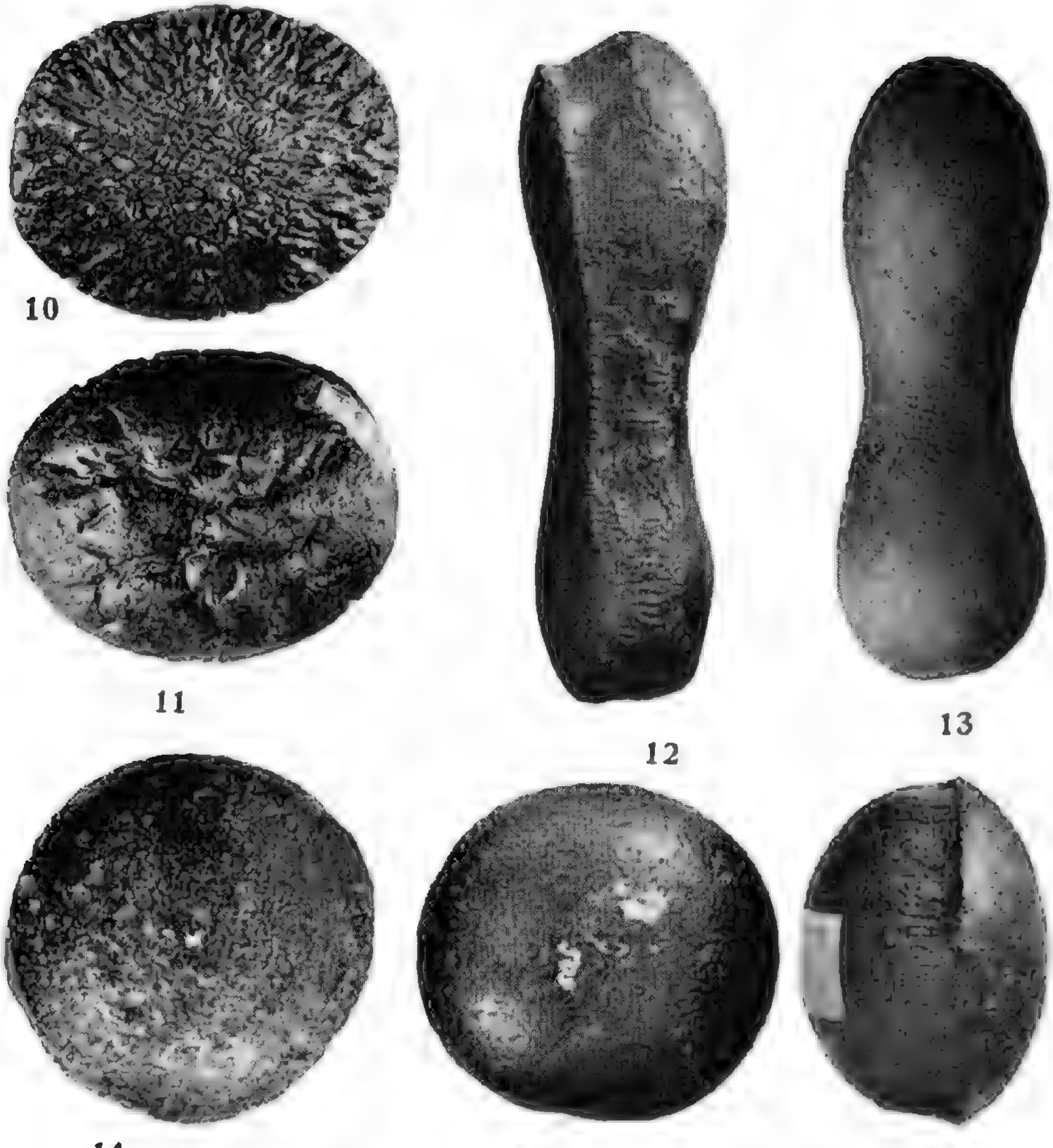
Plate Number	Type of Australite	Weight in grams	Size Measurements in Millimetres	Locality	Collector	Remarks	Present Location
Plate VII Nos. 1 and 2	Lens form	218	64 x 64.5 x 39.4	Lake Yearling, W.A. 32°S and 118°E.		Deeply pitted on top surface, some unusual markings on bottom surface.	Western Australian Museum, Perth.
Nos. 3 and 4	Boat form derived by abrasion from "bannock" form.	208.9	82 x 46.8 x 37.9	Karoonda, S.A. 35°S 140°E	V. O'Malley	Sides and bottom have been flaked off, perhaps during later part of flight or more likely when lying on the earth. Flow lines and pitting on top surface.	South Australian Museum, Adelaide.
Nos. 5 and 6		154.3	51.5 x 48.5 x 43	Western Australian Goldfields	Mr. Blackham	Subspherical in shape, much chipped, possibly by aborigines, certainly by human agencies.	In possession of Miss K. Blackham daughter of discoverer.
Nos. 7 and 8	Lens Core	113	52.1 x 51.5 x 36.5	Between Karoonda and Lowalde, S.A.	Owen Burgan	Slightly oval lens core. One large piece chipped out and a large burst bubble showing on upper surface.	
No. 9	Flanged oval				Charles Darwin		
Plate VIII Nos. 10 and 11	Lens Core	98	49 x 49 x 37	Nullarbor Plains, Southern Australia	W. H. C. Cook	Very perfect example of large lens core. Large number of radiating grooves on upper surface, and some wider grooves on lower surface.	South Australian Museum.
No. 12	Unsymmetrical dumb-bell.	94	21 at waist, 29 wide at larger end 27 wide at smaller end.	Near Warrnambool, Victoria			

LARGE AUSTRALITES

Plate Number	Type of Australite	Weight in grams	Size Measurements in Millimetres	Locality	Collector	Remarks	Present Location
No. 13	Dumb-bell	89	Length 76 Width at waist 18	Todmorden Station, S.A.	J. H. Johnston		
No. 14	Lens core	111	51.1 x 50.5 x 33.1	Norseman, W.A.	W. H. C. Cook	Very worn and sand-abraded	South Australian Museum.
Nos. 15 and 16	Lens core	101	49.1 x 45.5 x 35.5	Karoni, W.A.	J. W. Sheehan		
		147		Corrigan, W.A.			Western Australian Museum No. 3441
		116		Lake Buchanan, W.A. 25°30′S and 123°E			Western Australian Museum.
	Broad oval	112.9	52 x 46 x 37.5	Babakin, 170 miles east of Perth	O. G. Marshall	One large recent chip removed. Strangely devoid of usual bubbles and scratches.	South Australian Museum.
	Boat (narrow form, oval) tending to become dumb-bell.	88.8	79 x 29 x 25	Finniss Springs, Central Australia	Mr. Warren		South Australian Museum.
	Boat	68.7	66 x 30 x 25	Crown Point, Central Australia	Mrs. Childs		South Australian Museum.
	Teardrop	83.5		Near Renmark, S.A.		No flaked edge, no prominent flowlines.	
	Teardrop	78	52 x 35	Near Diamentina River, S.A.		Flow lines on top surface and very definite flaking on sides.	



Large Australites, Nos. 1-9.



Large Australites, Nos. 10-16

A HYBRID SWARM BETWEEN EUCALYPTUS ODORATA BEHR. AND EUCALYPTUS LEUCOXYLON F. MUELL.

*BY L. D. PRYOR**

Summary

Morphological and field evidence together with a progeny test strongly support the view that a segregating hybrid swarm exists between *Eucalyptus odorata* Behr. and *E. leucoxylon* F. Muell. in the vicinity of Burnside, South Australia. It is considered that individuals from this swarm should not be referred to *E. jugalis* Naudin, and that this name should be discarded as a *nomen dubium.* There is evidence that at least four distinct major populations of *Eucalyptus leucoxylon* exist which might well be described as sub-species.

A HYBRID SWARM BETWEEN EUCALYPTUS ODORATA BEHR. AND EUCALYPTUS LEUCOXYLON F. MUELL.

By L. D. Pryor *

(Communicated by T. R. N. Lothian)
[Read 8 July 1954]

SUMMARY

Morphological and field evidence together with a progeny test strongly support the view that a segregating hybrid swarm exists between *Eucalyptus odorata* Behr. and *E. leucoxylon* F. Muell. in the vicinity of Burnside, South Australia. It is considered that individuals from this swarm should not be referred to *E. jugalis* Naudin, and that this name should be discarded as a *nomen dubium*. There is evidence that at least four distinct major populations of *Eucalyptus leucoxylon* exist which might well be described as sub-species.

INTRODUCTION

It is known from studies in eastern Australia that hybrids are found between pairs of *Eucalyptus* species under certain conditions. The frequency with which they occur differs considerably from place to place. They are much more common between some pairs of species than others. They are particularly common between pairs of species belonging, one each to the two systematic groups of the genus, Porantheroideae and Terminales. For example, a hybrid swarm of this kind between *E. albens* and *E. sideroxylon* is well developed in the neighbourhood of Gundagai (Pryor, 1953). Similar cases have been found between such pairs of species in other parts of New South Wales and in Victoria. It is of interest, therefore, to record an examination made of a similar pair of species in South Australia, namely, *E. odorata* and *E. leucoxylon*, which belong respectively to the same groups and where the conclusions correspond closely with those reached in the other instances mentioned.

FIELD AND MORPHOLOGICAL EVIDENCE

The rising slopes between the Burnside tramway terminus and the Green Hill Road in the Adelaide suburbs pass through a boundary between the *E. odorata* association and the *E. leucoxylon* association. As a rule through this and adjoining areas, the two species occur separately as the only trees in pure stands.

The area has been much cut over and otherwise disturbed by settlement and there are many fewer trees than there were originally in the virgin state, though some may still remain which ante-date settlement. *E. camaldulensis* also occurs in this area, but is rather sharply cut off in its distribution by being confined to particular soil types.

There are a number of trees here which can be assigned readily to either *E. odorata* or *E. leucoxylon*, as they conform quite closely to the types of those species. On the other hand there are some groups of trees which contain individuals with characters forming a grading series between the two species. The most striking field character to show this gradation is the bark. *E. leucoxylon* is smooth-barked throughout, whereas *E. odorata* has a rough, dark greyish-brown sub-fibrous bark extending over the trunk and larger limbs to the small branches. Between these two extremes individuals are found with a small amount of rough bark at the base only, others with bark extending half way up the trunk, and then still others with it extending to the first large limbs and even to the smaller limbs. The same kind of variation can be seen in the general branching habit and form of the tree, but is more difficult to describe. In the inflorescence, buds and fruits similar variation is strikingly displayed. *E. odorata* has an inflorescence made up of "umbels" mostly seven or more flowered, although often reduced accidentally to fewer than seven as shown by remaining scars, whereas

* Department of the Interior, Canberra, A.C.T.

E. leucoxylon has three-flowered "umbels". Intermediate conditions are found on trees which also have the bark variations described above. Likewise, the same kind of grading occurs between the sub-cylindroid shortly petiolate buds of *E. odorata* to the ovoid, shortly rosrate, long pedicillate buds of *E. leucoxylon*. It was possible to obtain a series of fruiting umbels which illustrate the type of variation clearly. These are illustrated in fig. 1, which shows the graded change, particularly in fruit shape, size and pedicel length between the two species.

It will be noticed that specimens 50/782 and 50/781 occupy a position somewhere near the centre of the range of variation.

In progeny 50/781 the flowers had no staminodes which is a character of *E. odorata*, and therefore indicates a degree of independent assortment of characters since the fruit, at least in size and shape, approaches that of *E. leucoxylon* more closely than *E. odorata*. On the other hand, the flowers of 50/782 have staminodes present, some of which are tipped with an oil gland. The presence of staminodes is characteristic of *E. leucoxylon*, but the staminodes tipped with an oil gland has been found to be characteristic of hybrids between Porantheroideae and Terminales. It is found in both cases that the anther shape is irregular from anther to anther and covers a range the average of which is intermediate between the forms characteristic for Porantheroideae and Terminales. This kind of variation has been recorded by Todd (1953) between material at Kew now thought to have derived from hybrids between *E. siderophloia* and *E. paniculata* in New South Wales. It is also characteristic of the intermediates between *E. albens* and *E. sideroxylon* mentioned above (Pryor ibid.).

Since this evidence is closely in accord with that which has been found in hybrid swarms elsewhere, a progeny test was made.

PROGENY TEST

Seed was collected from open-pollinated capsules of several trees from the supposed swarm in this area, which covered the range between *E. leucoxylon* and *E. odorata*. From each of these progenies up to fifty plants were raised and examined when the eighth pair of leaves was fully developed. The juvenile leaves of the two supposed parent species are quite distinct at this stage. *E. leucoxylon* has sessile, opposite, somewhat ovate leaves which are cordate at the base, and *E. odorata* has petiolate, alternate, rather broadly elliptical leaves.

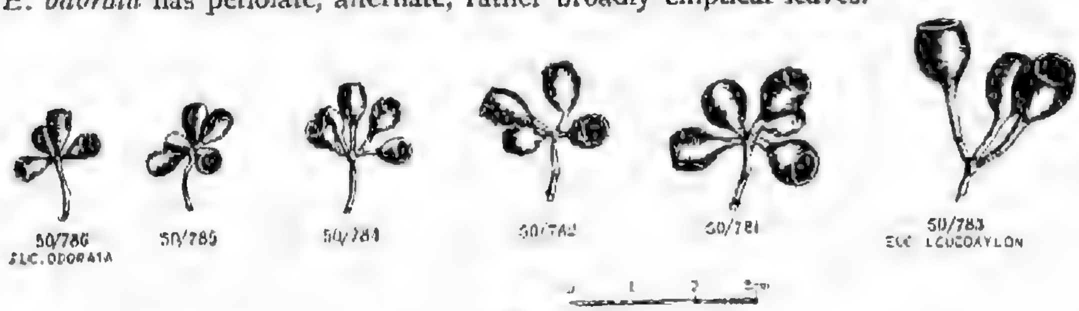


Fig. 1

In previous studies of this kind, measurement of leaf shape expressed by the ratio of length/breadth was used, but in this particular case the overall dimensions of the two species are rather similar and the simple representation of leaf shape is not available from this ratio. Measurements were therefore made of the length of petiole and the distance between the point of attachment of the petioles from each pair of leaves. The results of these measurements are set out in histograms in fig. 2. It was felt, however, when this material was examined and the supposed hybrid origin of the individuals supported by the progeny test, that progenies 50/786 and 50/783, although morphologically close to, or even identical with, the respective species, may each have had some inheritance from the other member of the pair. There was a tendency to this in the characters displayed by at least one of them (50/783). Unfortunately, also, both progenies were very small.

It was considered necessary, therefore, to raise two additional progenies, 5286 and 5287, from *E. odorata* and *E. leucoxylon* respectively, which were growing a substantial distance from a field junction between the two species. I owe my sincere thanks to Mr. C. D. Boomsma for collecting and sending the seed from which these two progenies were raised subsequent to the members of the swarm.

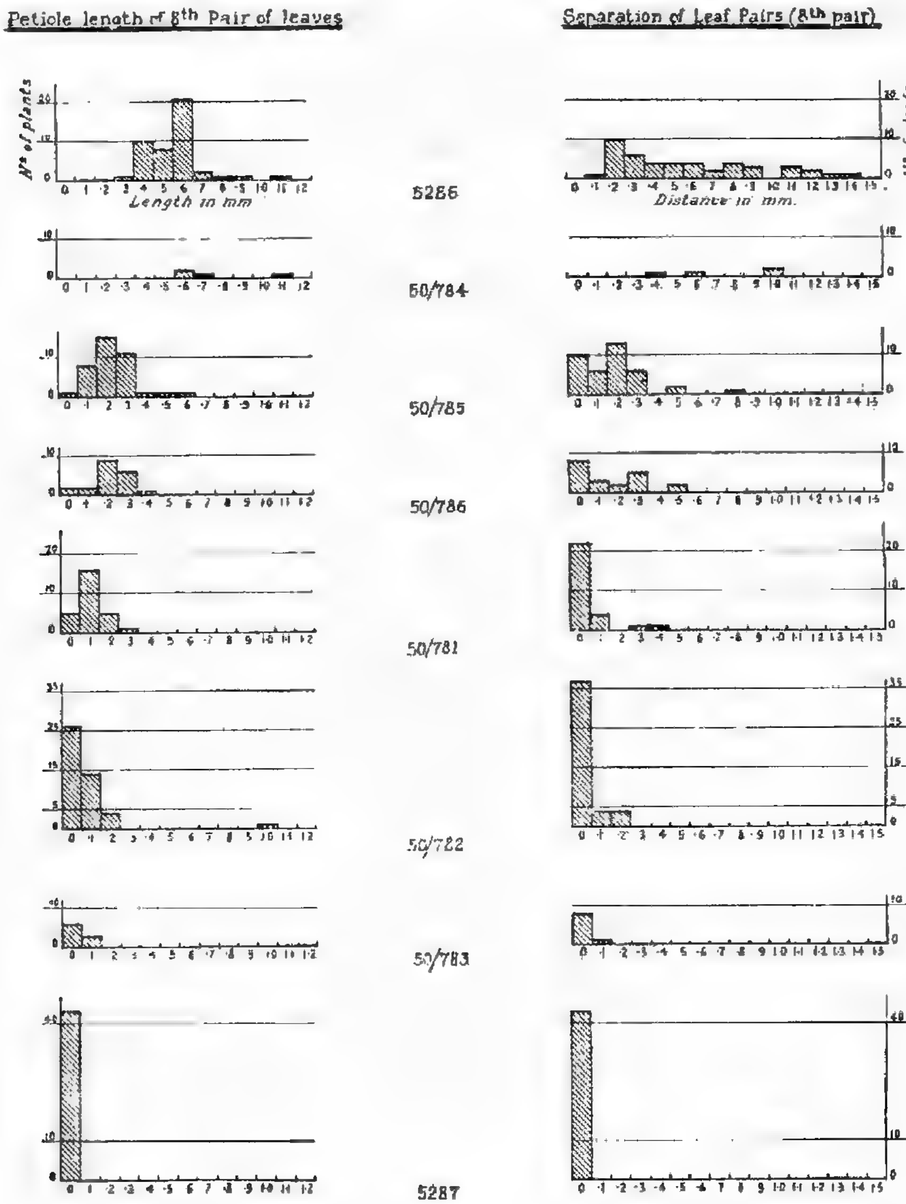


Fig. 2

It will be noted in the histograms of the length of petiole in the eighth pair of leaves, that there is a shift in the modal length through the various progenies from one parent to the other. It will be seen also that the same trend is followed in the measurement of the distance of separation of the point of attachment of petioles in the eighth pair of leaves, but that is not so clearly displayed because the variance in the pure *E. odorata* progeny is so much greater than in the remainder.

The sequence of this change through the progenies does not correspond closely with the sequence of variation shown for the fruit characters in fig. 1, indicating a degree of independent assortment of characters.

DISCUSSION

The evidence collected strongly supports the view that a hybrid swarm exists between *E. leucoxylon* and *E. odorata* in the area studied, and supplementary field observations suggest that such swarms are of frequent occurrence wherever a junction occurs in the field between the areas occupied by these two species. They are therefore quite widespread. The conclusion could be supported more rigorously by the manipulatied synthesis of the F1 hybrid between these two species and the raising of an F2 generation from that hybrid. This would, of course, take some years, and cannot be attempted yet, although it has been in progress for some time with a few other hybrid combinations. There is small doubt, however, from the evidence already accumulated, that the variation found in these individuals is correctly interpreted through hybridization leading to the development of a segregating hybrid swarm.

NOMENCLATURE

It has been the practice to refer some hybrid material (such as 50/781 and 50/782) to *E. jugalis* Naudin. Blakely (1934) equates *E. jugalis* Naudin with *E. leucoxylon* var. *pauperita* J. E. Brown. This raises some interesting points in nomenclature. J. E. Brown (N. D.) describes the type of *E. leucoxylon* F. Muell. as occupying the area of the central districts. *E. leucoxylon* var. *pauperita* J. E. Brown is described as occurring separately and in drier, more inland areas than the type, and *E. leucoxylon* var. *macrocarpa* J. E. Brown (in two forms differing only in filament colour) as occupying a rather narrower zone closely along the south coast in cooler and wetter areas than the type. These three taxa approximately typify three substantially distinct populations of *E. leucoxylon* and might very well be regarded as geographic sub-species, each taxon fairly representing a distinct and quite extensive population. The position is rendered a little less clear, however, by J. E. Brown's description of *E. leucoxylon* var. *pauperita*, which distinctly says that the umbels are two, three, or four-flowered. Syntype material examined in the National Herbarium, Sydney, shows it to be exclusively three-flowered. It seems likely that some minor, irregular variation in his type specimen led Brown to describe a four-flowered umbel; in the same way he described a two-flowered umbel which would certainly result from abortion or accidental loss of one flower in the umbel at some stage. Two-flowered umbels are shown in his plate in the Forest Flora of South Australia.

Maiden's illustration of *E. jugalis* Naudin corresponds closely with *E. leucoxylon* var. *pauperita* J. E. Brown, and also includes a pair of two-flowered umbels which may have been the condition which led to Brown describing a four-flowered umbel. On the other hand, Naudin's original description (in French) quoted by Maiden (Critical Revision) clearly says that the inflorescences are often three-flowered but sometimes have *five* or *seven* flowers and are shortly pedicellate. The presence in individuals which have many three-flowered umbels of some containing five or seven flowers, has been found in all cases so far critically examined, to be exclusively associated with hybridization. It seems highly probable, therefore, that the type of *E. jugalis* Naudin was a hybrid, but unless the original tree described by Naudin and planted presumably at Villa Thuret in France, can be found and a progeny test carried out, it is unlikely that it can certainly be identified. From the evidence available from the description, a tree conforming fairly closely to this description could have more than one hybrid origin. It may, for example, be a hybrid between *El leucoxylon* var. *pauperita* and *E. calcicultrix*, or between *E. leucoxylon* and *E. odorata*, or

perhaps between *E. leucoxylon* and *E. microcarpa*. It is interesting, also, to note that another geographic form of *E. leucoxylon* occurs extensively in Victoria, as, for example, from the vicinity of Stawell to south-west New South Wales, and also probably in parts of South Australia. Here the juvenile leaves are extremely glaucous, as also are the buds and fruits. The fruits have a relatively short pedicel and are also rather more hemispherical than the type. It could well be that *E. jugalis* Naudin was a hybrid derived from this form as the *E. leucoxylon* parent, because Naudin refers particularly to the *very* glacous buds, which is not characteristic of any of the three forms in South Australia, although a limited degree of glaucousness may at times occur in them.

There is little doubt that *E. jugalis* had some *E. leucoxylon* parentage and it seems, therefore, that the name "jugalis" can be applied legitimately only to a particular hybrid, the natural occurrence of which is not at present known nor likely to be revealed in the future. Nor is it likely that the "box" parent can be deduced.

It seems clear, therefore, that Blakely's synonymising of *E. jugalis* with *E. leucoxylon* var. *pauperita* cannot stand. Moreover, it is unlikely that any specimens can be referred with certainty to *E. jugalis*. It is considered, therefore, that the name *E. jugalis* should be regarded as *nomen dubium* and be discarded.

It is apparent that satisfactory treatment of *E. leucoxylon* must recognise at least four distinct geographic populations, which might be well described as four sub-species. These are at present represented by *E. leucoxylon* F. Muell., *E. leucoxylon* var. *pauperita*, J. E. Brown, *E. leucoxylon* var. *macrocarpa* J. E. Brown, and the population largely north-east and west of the Grampians in Victoria extending at least to Bordertown and Naracoorte with pruinose buds, fruits and juvenile leaves which possibly corresponds with *E. leucoxylon* var. *pruinosa* F. Muell. ex Miq.

It seems from this and similar investigations that a revision of many species of *Eucalyptus* can only be satisfactorily made if extensive planned collection and examination is made of each species throughout its range. Is must be expected in the course of such surveys that in many places, especially where in the pre-settlement state the area occupied by one species came in contact with the area of distribution of a species with which it could form hybrids, extensive hybrid swarms are now likely to exist and that the pattern of variation will be influenced often by this.

ACKNOWLEDGMENTS

I have pleasure in thanking Mr. C. D. Boomsma for assistance with supply of seed; Mr. L. A. S. Johnson for discussion, particularly on matters of nomenclature; and Mr. R. H. Anderson for free access to the collections in the Herbarium, Sydney.

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NOTE ON THE EUCOSMID (OLETHREUTID) MOTH CRYPTOPHLEBIA OMBRODELTA (LOWER)

*BY NORMAN B. TINDALE**

Summary

At the request of Mr. J. D. Bradley of the British Museum a search has been made in the Oswald B. Lower collection, at the South Australian Museum, for the type of the *Eucosmid (Olethreutid)* moth described from Sydney by Lower (1898, p. 48) under the name *Arotrophora* (?) *ombrodelta.*
There were five specimens in Lower's main collection preserved in the South Australian Museum, standing above a name label reading *Argyroploce illepida* Butler. Two examples were from Kuranda, Queensland, and three from Brisbane. Two of the latter bore his register number, L.2857.

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By Norman B. Tindale*

[Read 12 August 1954]

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There were five specimens in Lower's main collection preserved in the South Australian Museum, standing above a name label reading *Argyroploce illepida* Butler. Two examples were from Kuranda, Queensland, and three from Brisbane. Two of the latter bore his register number, L.2857.

Under this number an entry was found, reading:—"*Arotrophora ombrodelta* Lower. 5 specimens Sydney and Brisbane." Internal evidence suggested this entry was made between the years 1897 and 1900.

Lower seems subsequently to have made an amending entry indicating his later conclusion that the name *ombrodelta* was a synonym of *Argyroploce illepida* Butler. Another entry, possibly still later, says "? *pyrrhias Meyrick*."

The five examples grouped together by Lower in his collection agree with *Cryptophlebia ombrodelta* (Lower) as defined by Bradley (1953), and with ones from the T. P. Lucas collection picked out as *C. ombrodelta* by Mr. J. D. Bradley when making a brief passing visit to Adelaide in February 1954. Thus deductions made by him about the identity of Lower's species are confirmed.

If further check be needed it can be deduced from the register entries that the Brisbane specimens numbered L.2857, by O. B. Lower, belong to the species regarded by him as *ombrodelta*, and that at the time he made the entry he had acquired several Brisbane examples as well as possessing a Sydney specimen which was his type.

The Sydney specimen itself unfortunately was not present in the series in his main cabinet. It could have been destroyed. However, search in other drawers of duplicates produced a solitary female specimen, with one wing injured and labelled merely as "Australia, Lower Coll." This label had been placed on the specimen at the time of its acquisition by the South Australian Museum. Agreement between this specimen and the original description proved very close, and with reasonable certainty it may be regarded as the type. It can be assumed only that when Lower came to consider his species synonymous with Butler's *illepida*, he placed it among his duplicates as an example no longer of particular interest.

In view of the renewed interest in it the specimen has been restored to the main collection and provided with an appropriate label by the present writer. An entry has been made also in Lower's Register to indicate the circumstances of its recovery.

Fig. 1 is based on the type specimen, enlarged to approximately x4. The general colour of the wings and body is pale brown with darker greyish-brown markings. The large semilunate spot near tornus of forewing is rich chocolate brown outlined with pale ochreous brown.

As indicated by Bradley (1953, p. 681) the identification of *Cryptophlebia ombrodelta* has had the effect of replacing the somewhat more familiar, but later published name *C. carpophaga* Walsingham for this economically important pest of tropical and subtropical pods, fruits, seeds and stems.

* South Australian Museum.

Study of the South Australian Museum specimens enables some new locality records to be made so that its range, as so far known, is:—

Distribution in Australia—New South Wales: Sydney. Queensland: Brisbane, Duaringa, Kuranda, Northern Territory.

Distribution outside Australia (*fide* Bradley)—Java, Philippines, Guam, Dampier Island, Formosa, Ceylon and South Africa.

Foodplants on which it has been reported include:—*Parkinsonia aculeata* (leaves and pods), *Cassia* (pods of *C. fistula* and *C. occidentalis*), several species of *Acacia, Aegle marmelos* (fallen fruits), *Sesbania aculeata* (pods), *S. grandiflora* (seeds), *Feronia* (fruits), *Bauhinia purpurea* (pods), *Adenanthera pavonia, Pithecolobium dulce,* and it has occurred on orange fruits, litchi fruits and seeds, and tamarind fruits.

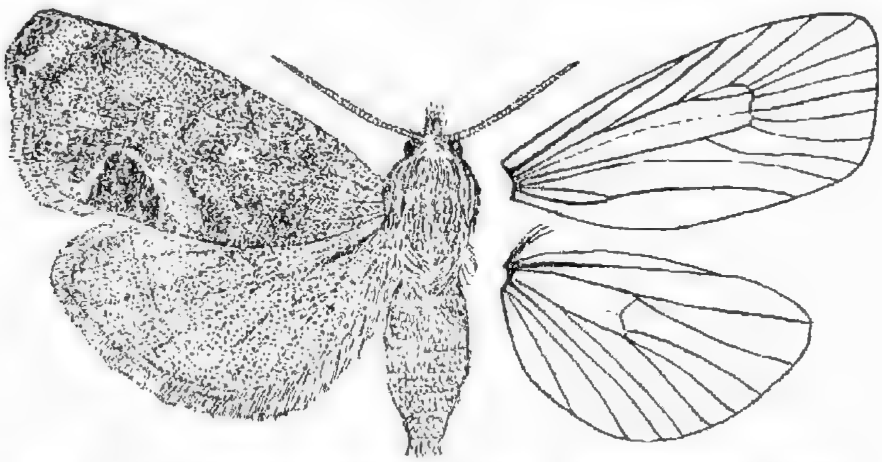

Fig. 1. *Cryptophlebia ombrodelta* (Lower). Type, a female, Sydney.

Seventeen other species of this genus are on record, of which the following have been reported from Australia:—

Cryptophlebia iridosoma (Meyrick)

Queensland: Brisbane, December 1905 (Lectotype in British Museum). This species is represented in the South Australian Museum by specimens from Brisbane, October 1885, Cairns district, and Kuranda.

Cryptophlebia rhynchias (Meyrick)

Reported from Queensland by Bradley but not represented in the South Australian Museum collection.

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THE EVAPORATION PATTERN OVER AUSTRALIA FOR THE MONTHS OF JANUARY AND JULY

BY C. W. BONYTHON,[(1)] *J. A. COLLINS*[(2)] *AND J. A. PRESCOTT*[(2)]

Summary

The evaporation pattern over Australia has previously been determined from actual evaporimeter measurements. It has now been re-computed, using evaporation rates calculated from physical theory and assuming there to be four effective meteorological factors, *viz.*, radiant energy, mean air temperature, humidity and wind. Mean rates have been calculated for January and July. These data have been compared with evaporimeter measurements and with an empirical derivation from saturation deficit.

The resulting evaporation pattern differs little from previous versions, but there is an anomaly meriting further study appearing in January in the Victoria- Tasmania region.

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By C. W. Bonython,[1] J. A. Collins[2] and J. A. Prescott[2]

[Read 14 October 1954]

SUMMARY

The evaporation pattern over Australia has previously been determined from actual evaporimeter measurements. It has now been re-computed, using evaporation rates calculated from physical theory and assuming there to be four effective meteorological factors, *viz.*, radiant energy, mean air temperature, humidity and wind. Mean rates have been calculated for January and July. These data have been compared with evaporimeter measurements and with an empirical derivation from saturation deficit.

The resulting evaporation pattern differs little from previous versions, but there is an anomaly meriting further study appearing in January in the Victoria-Tasmania region.

INTRODUCTION

The rate at which moisture is leaving the surface of the earth is recognised as an important climatological concept and its relationship to precipitation has been the subject of many discussions and the formulation of many climatic indices. These moisture indices form the basis of modern climatic classifications such as that of Thornthwaite (1948).

Much of this loss of moisture occurs as transpiration from the leaves of vegetation, some occurs as evaporation from soil and some as evaporation from the free surface of water. Transpiration, although different from evaporation, is usually close to and directly related to it.

Evaporation from a free water surface is that most readily measured and most easily reproduced when the extent of surface is specified. It has therefore become in itself a useful climatic index. Practical measurements are usually made from open vessels of water termed tank or pan evaporimeters.

Such tank evaporimeters have been used in Australia for many years and Foley (1947) has discussed the results of such measurements, and this discussion has formed the basis of the publication of a series of mean annual, mean six monthly, and mean monthly maps by the Commonwealth Meteorological Branch (1954) from data revised up to May 1953. These maps are based on estimates of evaporation based on the so-called Waite formula:

$$E = 21{\cdot}2\ (p_s - p_a) \qquad (1)$$

where E is the mean monthly evaporation

and $(p_s - p_a)$ is the corresponding atmospheric saturation deficit, p_s being the saturation water vapour pressure at the temperature of the air and p_a the actual vapour pressure. In this case vapour pressures are expressed in inches of mercury, as established by Prescott (1938), and modified by reference to actual evaporation records for tanks.

Tank evaporimeters are not, however, sufficiently numerous, nor sufficiently evenly distributed to show accurately in themselves the complete pattern of evaporation, and they are subject to certain hazards and practical difficulties,

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[2] Waite Agricultural Research Institute, University of Adelaide.

some of which have been described by Foley and by Bonython (1950). However, since it is known that the evaporation from a free water surface is dependent upon fully understood physical principles involving parameters relating to meteorological factors which are all measurable, there is some advantage in calculating evaporation according to these principles in order to avoid the practical difficulties inherent in the use of evaporimeters.

The accuracy of these meteorological observations then becomes important, but the individual factors are often widely measured and their variations are well understood, so that values which are most representative of large areas of country can be derived and used. This is particularly true of the wind factor. It is difficult to ensure that an evaporimeter is exposed under the mean wind conditions of the district, but in the calculations to which reference is made, it becomes possible to use values for wind speed extrapolated either from wind measured at a high level or from the geostrophic wind and in this way avoid becoming involved in the microclimatic complexities of the locality.

Penman (1950) has determined the evaporation pattern of the British Isles by means of such calculations.

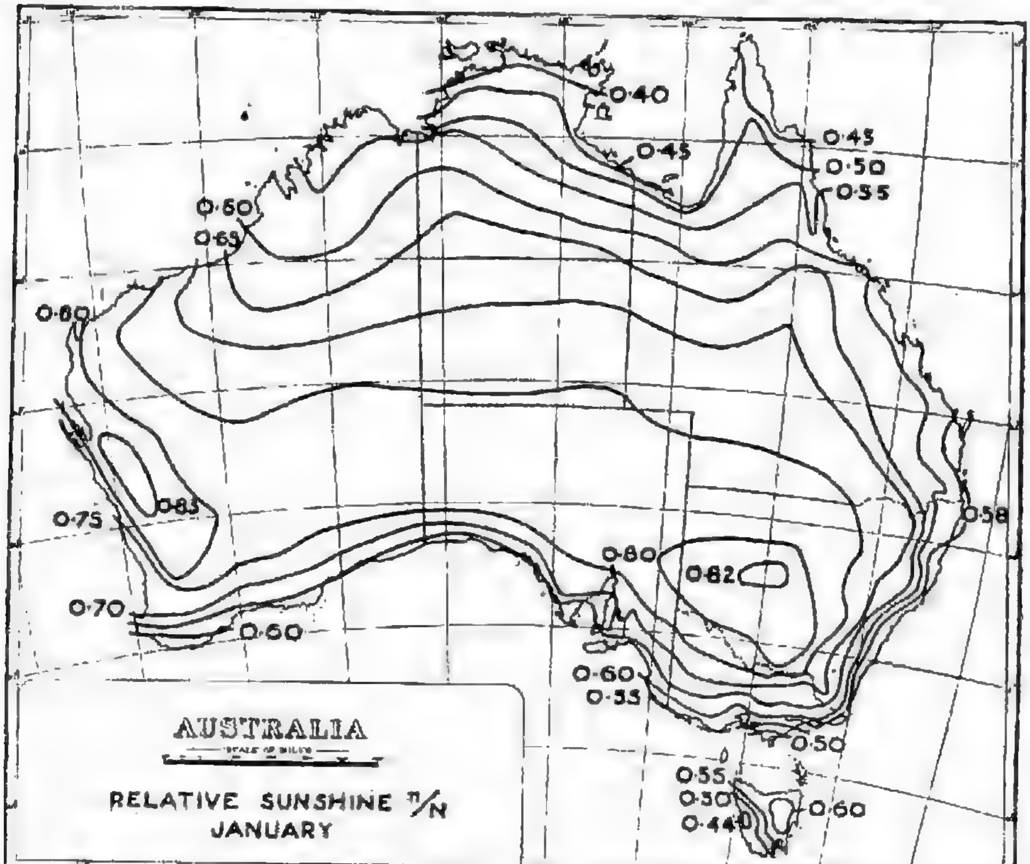

Fig. 1

The Physical Theory

The physical theory of natural evaporation from a free water surface has been placed on a sound basis by the work of Penman (1948) and Ferguson (1952). These workers recognised that solar and atmospheric radiation, air temperature, humidity and wind are the four meteorological factors determining the rate of evaporation. It is proposed here to use the equation of Ferguson.

This equation is based on the Dalton equation (2), into which is then incorporated a method of calculating the vapour pressure at the water surface from the four meteorological factors.

$$w = k\,(p_w - p_a) \qquad (2)$$

where w is the weight of water evaporated in unit time from a unit area,

k is the coefficient of mass diffusion between the water and the air, p_w is the vapour pressure at the evaporating surface, and p_a is the partial pressure of water vapour in the air above the surface as indicated above.

Ferguson has shown that, on the basis of the empirical relationship between the coefficients of heat and mass transfer for evaporation of water into air:

$$\frac{h}{L\,k} = 0{\cdot}50 \qquad (3)$$

where h is the coefficient of heat transfer and L is the latent heat of vaporization when temperatures are in degrees Centigrade and the vapour pressure is in millimetres of mercury.

The vapour pressure of the evaporating surface can be expressed by:

$$p_w = X_\theta\left(\frac{Q}{h} + 2\,p_a + \theta_a\right) \qquad (4)$$

where X_θ is a function of the water temperature, Q is the nett gain of radiant energy by the water surface and θ_a is the air temperature.

Substitution in equation (2) gives rise to the equation:

$$E = \frac{2h}{L}\left[X_\theta\left(\frac{Q}{h} + 2p_a + \theta_a\right) - p_a\right] \qquad (5)$$

where k has been replaced by its equivalent in h, and w by E,

Expressed in specific terms (5) becomes:

$$E_{31} = h\left[X_\theta\left(\frac{Q}{h} + 2p_a + \theta_a\right) - p_a\right] \qquad (6)$$

where E_{31} is the rate of evaporation in inches per month of 31 days, h is the coefficient of heat transfer in cal./cm^2/hr./°C, Q is the nett gain of radiant energy in cals./cm.^{2}/hr., p_a is the atmospheric humidity expressed as the partial pressure of water vapour in mm. of mercury, θ_a is the air temperature and X_θ is a function of temperature (see Table 1).

By a coincidence the numerical constant of equation (6), for the specific combination of units and rates, is 1·0 and hence no numerical constant is shown. Strictly X_θ is referred to the temperature of the water, but as this is one of the unknowns the appropriate values are found from the air temperature θ_a.

This is admissable in practice since under most natural conditions the temperatures of the air and water are close together and X_θ changes only slowly with temperature.

TABLE I

values of X_θ for values of θ for water

Temperature (θ)	X_θ	Temperature (θ)	X_θ
°C		°C	
5	0·361	18	0·317
6	0·349	19	0·317
7	0·341	20	0·318
8	0·334	21	0·320
9	0·328	22	0·322
10	0·324	23	0·324
11	0·320	24	0·326
12	0·318	25	0·328
13	0·317	26	0·330
14	0·316	27	0·333
15	0·315	28	0·335
16	0·315	29	0·337
17	0·316	30	0·340

Equation (6) is for the steady state where no term for heat storage is necessary, and hence no allowance is made for the constantly varying conditions and the changes in stored heat so characteristic of natural conditions. Ferguson has shown, however, that equation (6) gives reasonably accurate results when the mean values of the meteorological data are used providing that the pond is shallow and that the period of time considered is at least two or three days.

CALCULATING THE RATE OF EVAPORATION

Equation (6) has been used in calculating the monthly rate of evaporation for the appropriate stations listed in Pamphlet 42 of the Council for Scientific and Industrial Research (1933). The appropriate meteorological data provided in this pamphlet are the mean monthly values for maximum and minimum temperatures and for relative humidity. Two hundred and ninety stations are represented in the calculations. The values so obtained have been entered on a map of Australia and appropriate lines of equal evaporation drawn for the two months of January and July. In view of the possible early publication of up-to-date normals for these meteorological factors and in view of the fact that the calculations were intended primarily to be a test of the Ferguson equation, it was not considered desirable at this stage to carry the calculations further so as to include all months of the year. The basic climatic values have been derived and handled as follows:

Nett gain of radiant energy—This quantity Q includes radiation of two types—short-wave solar radiation and long-wave atmospheric radiation. Insolation reaching the water surface suffers a small loss by reflection, the balance entering the water where it is assumed to be fully absorbed. The water surface radiates out long-wave energy almost as a black body, but this loss is partly offset by a downward stream of long-wave radiation from the atmosphere.

Insolation is frequently measured by means of the solarimetric thermopile, but very few regular measurements are made of atmospheric radiation and this is usually estimated from meteorological data using empirical formulae like those listed by Brunt (1944) and more recently by Anderson (1952). In Australia there are so few direct measurements of insolation available that for the purpose of this paper the quantity has been derived from relative sunshine, using for this purpose maps supplied by the Commonwealth Meteorological Branch, of the duration of sunshine for January and July based in part on sunshine recorders

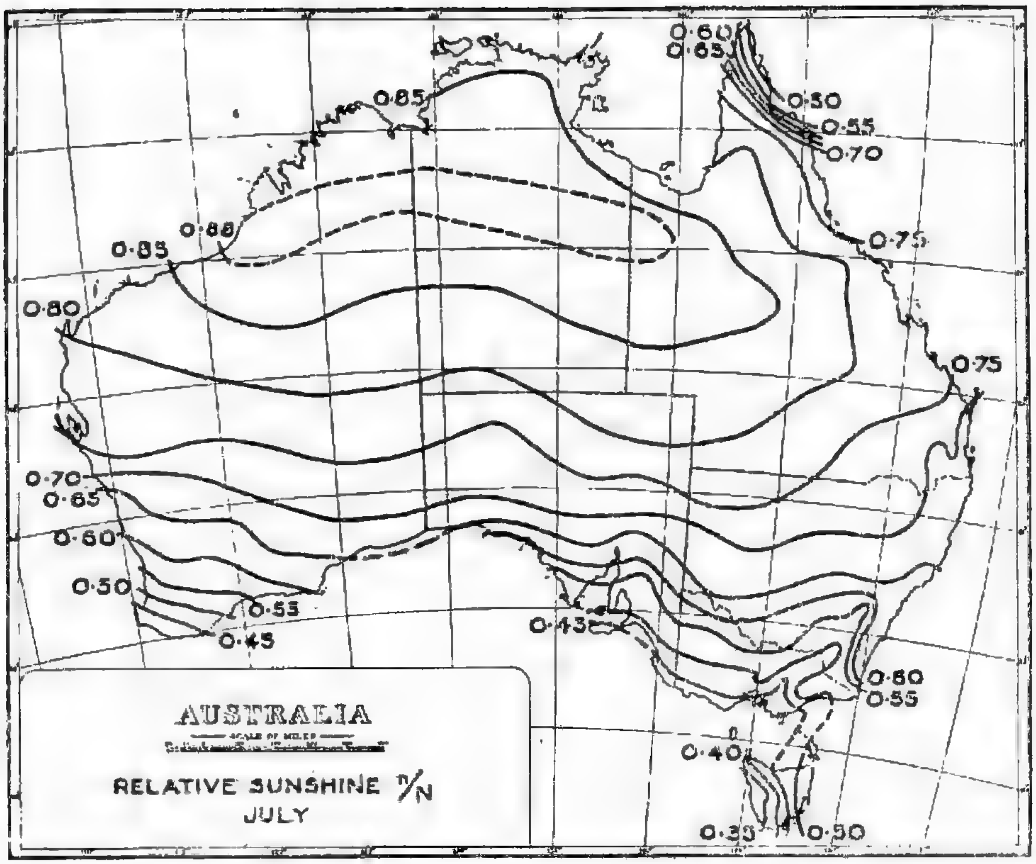

Fig. 2

and in part on observations of cloudiness. These two maps of relative sunshine are illustrated in figs. 1 and 2.

Black, Bonython and Prescott (1954) have shown that the insolation reaching the earth's surface can be calculated from relative sunshine by means of the equation:

$$\frac{Q}{Q_A} = a + b\frac{n}{N} \qquad (7)$$

where Q is radiation actually received, Q_A is the theoretical radiation for an airless earth (Angot's value), n is the actual duration of sunshine and N is the maximum possible duration of sunshine. In these calculations for Australia the parameters in this equation for the observations at Dry Creek, South Australia, have been selected, namely $a = 0{\cdot}3$ and $b = 0{\cdot}5$. There is a suggestion in some of the detailed records examined that the parameter a varies with latitude, but this is not confirmed by the broader statistical analysis of the wider records.

The loss by reflection on clear days in temperate latitudes is small and is practically constant throughout the year. It can be approximately corrected for cloudiness by multiplying by relative sunshine $\frac{n}{N}$.

The nett loss of long-wave radiation is allowed for in a simple manner by taking into account cloudiness and humidity but not air temperature. The combined short-wave and long-wave expression appropriate for the calculation of nett radiation received is:

$$Q = 0{\cdot}3\, Q_A + \frac{n}{N}\left(\frac{Q_A}{2} + \frac{p_a}{4} - 11{\cdot}4\right) - 1 \qquad (8)$$

where Q is the nett gain of radiant energy for a horizontal surface in cals./cm.^{2}/hour.

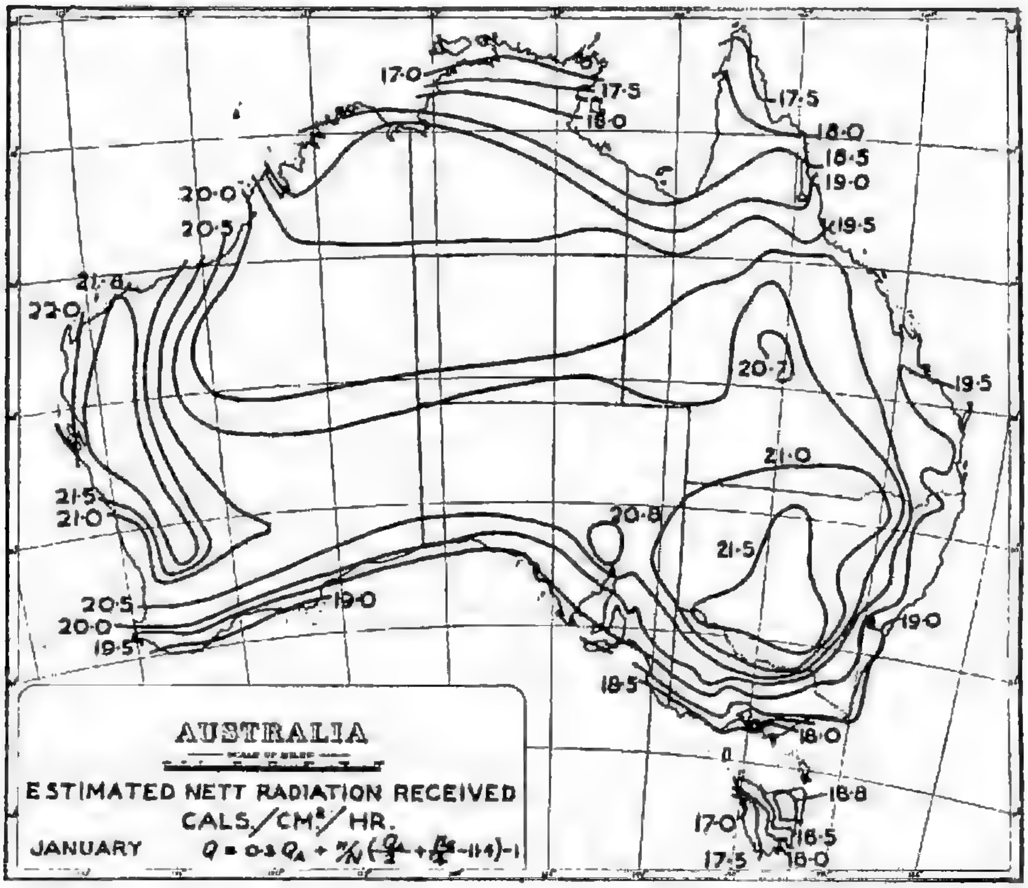

Fig. 3

Air temperature—This quantity θ_a is the mean of the mean monthly maximum and minimum temperatures. It is expressed in degrees Centigrade.

Humidity—This quantity p_a is derived from the mean temperature as defined above and the relative humidity. It is expressed as mm. of mercury.

Heat transfer coefficient—This parameter h is interchangeable with the mass tranfer coefficient k. It is preferable to use the former because its value on an hourly basis is conveniently close to unity under most conditions of natural evaporation. These transfer coefficients are empirically related to horizontal wind speed, and for the present purposes the value of h is based on the relationship to wind velocity found by Bonython (1950) for the standard Australian tank evaporimeter three feet in diameter. In view of the difficulties of obtaining

records of wind velocity over the continent, B. Mason[1] calculated the mean wind speed for a height of one metre by extrapolation from the geostrophic wind, using as check points the wind speeds measured by Dines anemograph at the main Australian airports. This pattern of wind speed expressed in terms of the parameter h was presented in the form of maps for January and July.

E. L. Deacon[2] has confirmed the admissability of this procedure in reference to certain wind stations on Salisbury Plain in England.

For January the value of h ranges from 1·8 near to Cape Leeuwin to less than 0·75 in parts of the interior, for July the values range from 1·2 to 0·8.

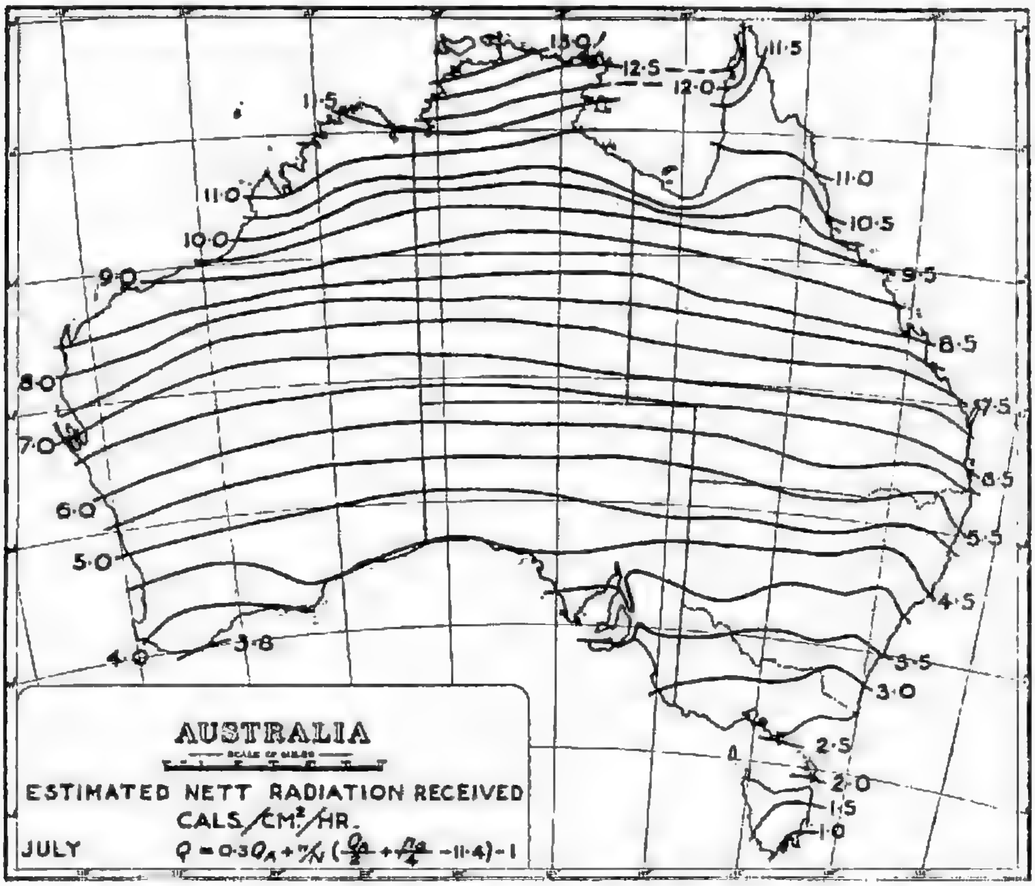

Fig. 4

Maps of the nett gain of radiant energy and of the rate of evaporation derived from the equations (8) and (6) are given in figs. 3, 4, 5 and 6 for the two months concerned.

The observed and calculated values of evaporation for 41 evaporimeter stations are given in Table 2. For a number of these it has been possible also to list the evaporation calculated from the normal published values of saturation deficit, using the "Waite formula" of the Commonwealth Weather Bureau.

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(1) (2) Privately communicated in each case.

TABLE 2

Comparison of observed and calculated evaporation for January and July

LOCALITY	JANUARY Observed	JANUARY Calculated from energy balance	JANUARY Calculated from saturation deficit	JULY Observed	JULY Calculated from energy balance	JULY Calculated from saturation deficit
	ins./month	ins./month	ins./month	ins./month	ins./month	ins./month
Western Australia						
Chapman	11·94	12·80	—	2·47	3·50	—
Merredin	12·96	12·60	—	2·12	2·10	—
Narrogin	9·19	12·10	—	1·62	1·80	—
Perth	10·37	12·65	8·83	1·76	2·64	2·07
Marble Bar	11·00	14·28	18·03	5·60	6·00	7·64
Coolgardie	12·48	12·11	—	2·44	2·47	—
Eucla	6·75	10·20	7·26	2·49	2·84	—
South Australia and Northern Territory						
Adelaide	9·27	12·41	11·33	1·39	2·07	1·88
Alice Springs	12·40	13·35	13·83	3·75	3·73	3·00
Darwin	5·28	7·60	3·13	8·23	7·29	4·69
Kybybolite	7·47	10·00	6·64	1·28	1·50	0·69
Waite Institute	8·57	10·76	8·44	1·71	1·92	1·93
Yudnapinna	14·62	12·35	10·61	3·04	2·50	1·91
Queensland						
Biloela	9·39	8·70	7·26	3·66	3·70	2·44
Brisbane	6·74	8·90	7·01	2·69	3·15	5·76
Rockhampton	5·68	9·11	6·95	2·67	3·99	3·26
Gilruth Plains	14·33	12·25	14·90	3·60	2·84	2·75
New South Wales						
Burrenjuck	6·19	9·00	—	·85	1·49	—
Canberra	8·84	9·34	7·14	1·33	1·41	1·00
Cowra	8·44	9·60	11·52	1·55	1·60	1·25
Griffith	9·32	10·13	—	1·46	1·68	—
Dubbo	10·91	10·41	10·26	1·40	1·74	0·95
Leeton	8·58	10·46	10·58	1·13	1·63	1·25
Yenda	8·91	10·48	—	1·38	1·64	—
Trangie	10·40	10·85	—	1·68	1·89	—
Bathurst	7·21	8·79	6·32	1·18	1·60	0·88
Hume	7·21	10·07	—	0·87	1·35	—
Lake Victoria	9·48	11·50	8·39	1·57	1·74	1·06
Sydney	5·42	8·76	5·70	1·56	2·06	1·88
Umberumberka	12·71	12·43	11·89	2·92	2·21	3·13
Walgett	8·08	11·15	11·77	2·00	2·26	1·57
Wilcannia	9·46	12·71	14·52	1·95	2·17	1·88
Victoria						
Geelong salt	6·89	9·14	5·38	1·95	1·52	1·19
Laverton	7·74	9·17	—	1·36	1·39	—
Melbourne	6·45	9·40	6·39	1·12	1·51	1·13
Merbein	9·71	10·38	—	1·78	1·70	—
Rutherglen	8·63	10·92	—	0·86	1·41	—
Walpeup	10·56	10·60	—	1·37	1·60	—
Werribee	6·97	9·17	—	1·31	1·39	—
Tasmania						
Cressy	5·11	8·81	4·95	0·97	0·85	0·69
Hobart	4·84	8·62	5·01	0·94	0·99	1·25

DISCUSSION

The evaporation map for January (fig. 5) shows mainly concentric lines roughly parallel with the coast, the rate increasing inland. There is a central area of highest evaporation over the Lake Eyre basin, and a secondary closed system of equally high evaporation in the far west between Latitudes 20° and 30° S. The map for July (fig. 6) shows lines of equal evaporation stretching across the continent, approximately along the parallels of Latitude and showing an increase in evaporation from south to north. The maps show considerable resemblance to the official maps of 1954, so far as the general pattern is concerned, with the best agreement for the month of July. The region of greatest disagreement is Victoria and Tasmania for the month of January, where the evaporation shown in fig. 5 considerably exceeds that of the official maps. These

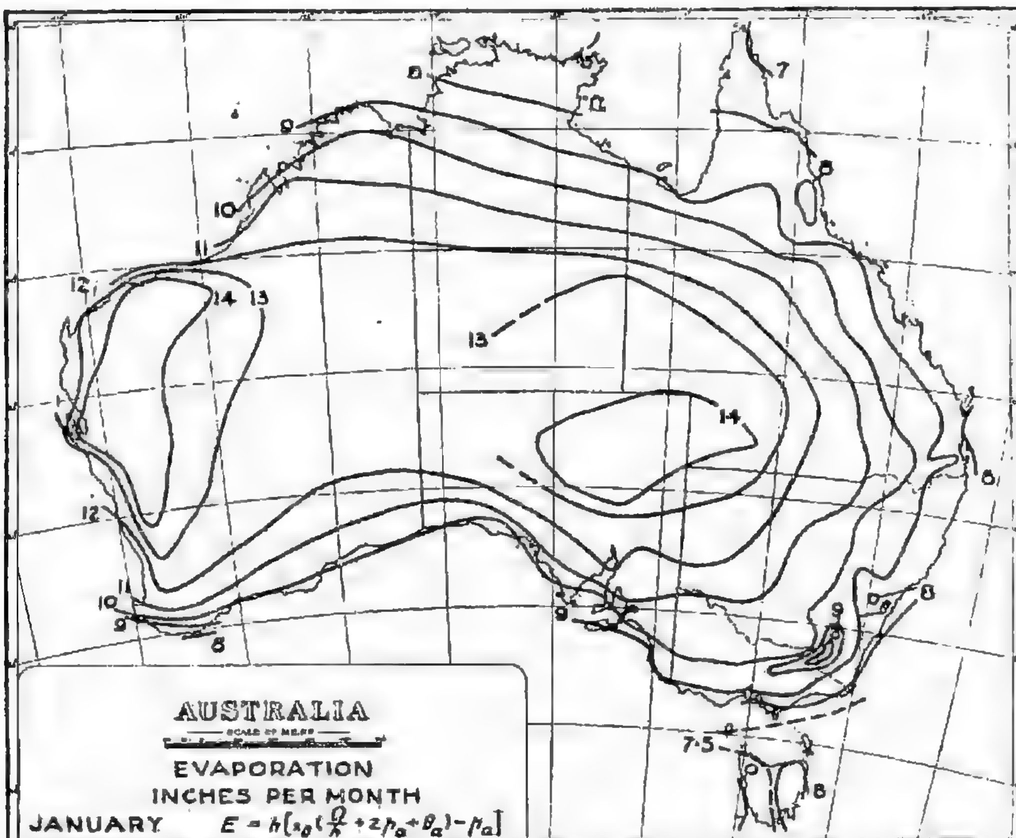

Fig. 5

differences are emphasised in the data of Table 2 where the observed evaporations and those calculated from atmospheric saturation deficit are derived as far as possible from the current meteorological summaries. The differences between the observed values and those calculated from the Ferguson equation of energy balance are greater in January than in July. In general, calculated evaporations are greater than observed evaporations. The discrepancy between observed and calculated evaporation for Victoria and Tasmania needs further investigation, particularly as the calculations from saturation deficit are generally much closer to the observed values. Certain stations listed in Table 2 were discussed by Foley

as recording anomalous values for evaporation. Of these, Marble Bar, Walgett and Wilcannia record lower values than would be expected from the saturation deficit, and Yudnapinna records much higher values. It will be observed from the Table that these deviations are maintained when the evaporation is calculated from the Ferguson equation. A first inference is that observations of evaporation for these places are suspect. Another is that the meteorological parameters common to the two processes of calculation are in some way erroneous.

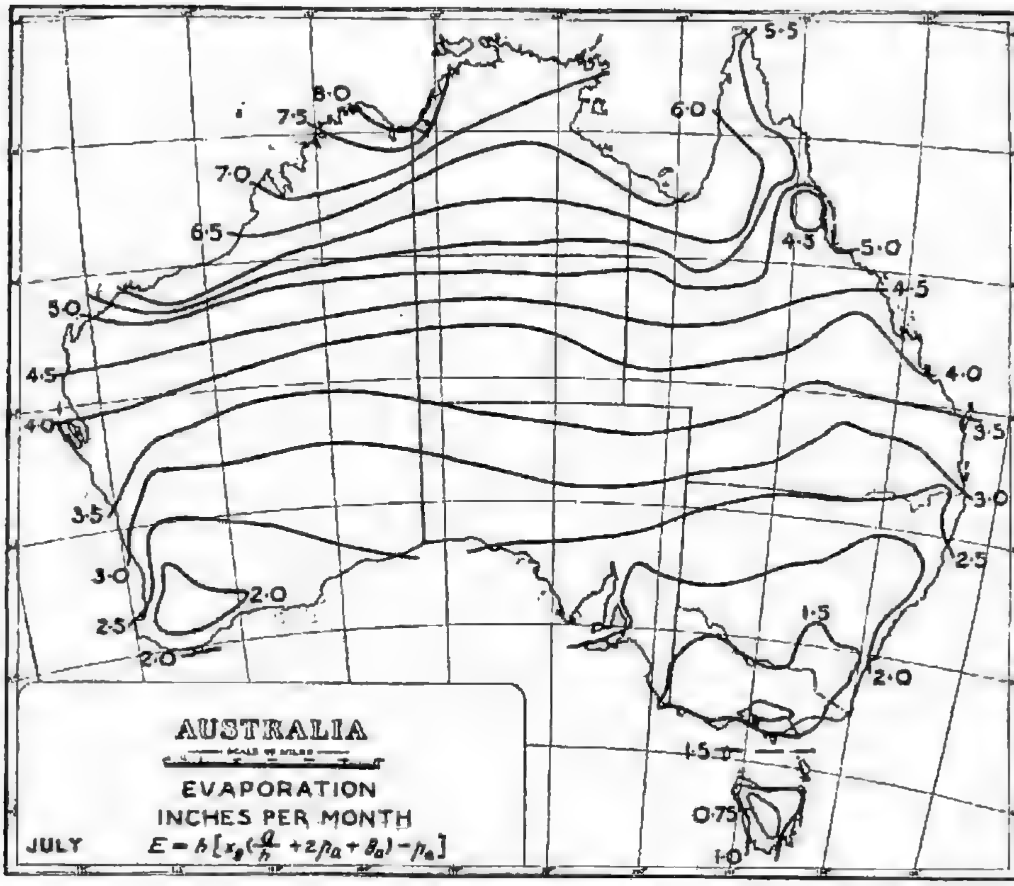

Fig. 6

In any case it is interesting to speculate why a calculation based on saturation deficit, which involves only temperature and humidity, should correlate so well with one involving also radiant energy and wind. In the first place it should be noted that equation (1) which is used in the calculations involving saturation deficit is a purely empirical one based on the regression equation between observed values for evaporation and saturation deficit, whereas those derived from the Ferguson equation are based more directly on physical principles, with empirical factors relating only to standard meteorological elements.

Equation (1) is in fact only a particular case of Equation (2) where k remains constant and $p_s = p_w$, that is, the evaporating water is at exactly air temperature. The good correlation can therefore be explained by the fact that, at a given time k (or h) may not vary very greatly over a considerable area of country, and also by the fact that the difference in temperature between air and evaporating water is frequently small over quite a range of natural condi-

tions. Another point is that the rise and fall of mean air temperature usually follows closely the rise and fall of the mean rate of insolation, the nett result being that when insolation and temperature are high or low, saturation deficit is similarly high or low. The factor that militates against the use of these simpler correlations is that evaporation is never quite in phase with the individual meteorological parameters, except possibly with those based on air movement.

It is interesting to recall here the further empirical correlations which have been found between evaporation and insolation and between evaporation and temperature by Prescott (1940, 1943). In essence, evaporation of any kind calls for a source of energy, in this case solar radiation, and there is no doubt that the estimation of evaporation in the future will take into account this source of latent heat as well as the atmospheric factors of temperature, humidity and air movement.

ACKNOWLEDGMENTS

The authors are indebted to Mrs. I. Mathison of the Waite Agricultural Research Institute for organizing the necessary computations, to Mr. B. Mason, South Australian State Climatologist of the Commonwealth Meteorological Branch, for determining wind patterns over Australia, and to Dr. C. H. B. Priestley and Mr. E. L. Deacon, of the Section of Meteorological Physics, C.S.I.R.O., for advice concerning vertical wind structure. They also wish to thank the headquarters of the Commonwealth Meteorological Branch for preparing sunshine maps of Australia, and in particular Mr. J. C. Foley of that Branch, for helpful advice on the handling of observed Australian evaporation data.

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NOTES ON THE FLORA OF SOUTH AUSTRALIA NO. 6[1]

BY ERNEST H. ISING

Summary

The paper describes one new genus and seven new species of South Australian plants. Five of them are in Chenopodiaceae, *viz.*, *Atriplex sessilifolia* n.sp., *Kochia concava* n.sp., *K. ovata* n.sp., *Malacocera biflora* n. sp. and *Bassia holtiana* n. sp.

Carinavalva glauca n. gen. et n.sp. in Cruciferae and *Goodenia helenae* n.sp. in Goodeniaceae are also included.

Species recorded for the first time in South Australia are *Lepidium strongylophyllum* F. v. M. in Cruciferae and **Osteospermum calendulaceum* L. f. in Compositae. The latter species is an introduction from South Africa, as is the showy yellow daisy, **Senecio pterophorus* DC., which is spreading near Mount Lofty and could become a pest on cultivated land.

All the new species were found in the Oodnadatta district, mostly on Evelyn Downs, the property of Mr. R. G. Holt.

NOTES ON THE FLORA OF SOUTH AUSTRALIA
No. 6 [1]

(With descriptions of one new genus and seven new species)

By Ernest H. Ising
(Communicated by C. M. Eardley *)

[Read 12 August 1954]

SUMMARY

The paper describes one new genus and seven new species of South Australian plants. Five of them are in Chenopodiaceae, *viz.*, *Atriplex sessilifolia* n.sp., *Kochia concava* n. sp., *K. ovata* n. sp., *Malacocera biflora* n. sp. and *Bassia holtiana* n. sp.

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All the new species were found in the Oodnadatta district, mostly on Evelyn Downs, the property of Mr. R. G. Holt.

Most of the species mentioned in this paper were collected by me on Evelyn Downs, 90 miles south-west of Oodnadatta, a sheep station owned by Mr. R. G. Holt. Through the hospitality of Mr. and Mrs. R. G. Holt and the transport provided, I have been able to collect botanical specimens during the past five years.

The abbreviations set out below have been used for the names of the herbaria mentioned, according to "Index Herbariorum," Pt. I, 2nd Ed., by J. Lanjouw and F. A. Staflen.

AD .... Herbarium of the University of Adelaide, soon to be housed in the new State Herbarium, Botanic Garden, Adelaide.
K .... The Herbarium, Royal Botanic Gardens, Kew, England.
MEL .... National Herbarium of Victoria, Melbourne.
NSW .... National Herbarium of New South Wales, Sydney.

Gramineae

Digitaria coenicola Nees. Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising*, No. 3628, 8.10.53. This is the first record for our Far North. Identification by Mr. L. D. Williams.

Proteaceae

Adenanthos terminalis R. Br. Wanilla, Eyre Peninsula, *E. H. Ising*, No. 3413, 2.9.38. First record for Eyre Peninsula.

Loranthaceae

Additional host plants can now be recorded for three species of *Loranthus*, all from Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising*.

Loranthus exocarpi Behr. On *Acacia tetragonophylla* F. v. M., October 1950 and 31.7.51; on *Pittosporum phillyraeoides* DC., 31.8.51 and 7.10.53; *Eremophila duttonii* F. v. M., 20.7.51; on *Cassia phyllodinea* R. Br., 22.9.53.

L. preissii Miq. On *Acacia cambagei* R. T. Baker, 26.7.51 and 9.8.51.

L. maidenii Blakely. On *Acacia cambagei* R. T. Baker, 26.7.51.

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* University of Adelaide.

(1) Paper No. 5 in this series appeared in 1937, Trans. Roy. Soc. S. Aust., 61, 221.

CHENOPODIACEAE

Atriplex sessilifolia n. sp.

Suffrutex usque ad 15 cm. alt., perennis, unisexualis, ramis procumbentibus demum erectis, subalbis, squamo-tomentosis; folia 4-7 x 3-5 mm., ovata, acuminata, integra, sessillia, glauco-virentia, tomento squamoso albido, in ramis distaliter conferta; *flores* axillares, fasciculati; *bracteoli* fructus circa 4 mm. long., et 5 mm. lat., tenui, resticulati, suborbiculati, basi cordati, margine integri, mucronibus venarum palmatarum exceptis, usque ad basin aperti; *appendices* nullae; *pedicellus* 1 mm. long.; *styli* 2, circa 2 mm. long.; *semina* erecta, radiculo laterali.

Undershrub up to 15 cm. high, perennial, branches procumbent and finally erect, whitish with scaly tomentum; *leaves* 4-7 mm. long, 3-5 mm. wide, ovate, acuminate, entire, sessile, pale green with whitish scaly tomentum, densely placed specially in upper part of branches; *flowers* dioecious, in axillary clusters; *fruiting bracteoles* about 4 mm. long and 5 mm. wide, thin, reticulate, suborbicular, cordate at base, margins entire except for mucro terminating each of the palmate veins, open to base; *appendages* absent; *pedicel* 1 mm. long; *styles 2* about half as long as bracteole; *seed* vertical with lateral radicle. *Male plant* not seen.

Mount Willoughby Station, about 80 miles south-west of Oodnadatta, *E. H. Ising*, No. 3570, 12.8.52, fig. 1, 14-16, the holotype. The *holotype* (AD) consists of one complete plant and one piece (isotype NSW). Another complete plant (paratype) was collected at the same time and at the same place and this is also in the Adelaide University Herbarium. This is all that was collected, both of them female plants and both bear the No. 3570, and all are covered by the description herewith.

The new species is nearest to *Atriplex cordifolia* J. M. Black but differs in being a woody perennial; leaves smaller, entire, pale green with whitish scales, not cordate; flowers dioecious; fruiting bracteole suborbicular with marginal teeth at extremity of palmate veins.

Bassia holtiana n. sp.

Suffrutex usque ad 25 cm. alt., ramis diffusis, albo-tomentosis; *folia* plana, linearia, 5-15 mm. long., villosa, dispersa; *flores* solitarii; *perianthus* fructus durus, albo-tomentosus, circa 3 mm. long. et diam., membro subnullo, facie anteriore subplana, verticaliter pluri-costata, facie posteriore breviter gibbosa; *basis* perianthi fortiter concava, oblonga, obliqua, magna; *spinae* 2, glabri, tuberculati, longiori 6-7 mm. divergenti, breviore 3-4 mm. latius divergenti (raro tertius brevis adest); *semina* erecta.

Small *undershrub* up to 25 cm. high, branches mostly diffuse, white-tomentose; *leaves* flat, linear 5-15 mm. long, scattered, villous; *flowers* solitary; *fruiting perianth* hard, white-tomentose, about 3 mm. long and broad, limb almost wanting, anterior face almost flat with several vertical ribs, posterior face somewhat gibbous; *base* deeply hollowed, oblong, very oblique, large; *spines* 2, glabrous, mostly with a tubercle, rarely a third short spine, the longer one 6-7 mm., divergent, shorter one 3-4 mm. and more widely divergent; *seed* vertical. Evelyn Downs, 90 miles south-west of Oodnadatta, found on this Station and named in honour of the owner, Mr. R. G. Holt. *E. H. Ising*, No. 3624, August 1953, fig. I, 17-19, the *holotype* (AD) consists of ten pieces off the type plant (isotypes) and all are covered by the description herewith. Besides the holotype, I collected, from the same locality and at the same time, different specimens of the new species and these are given different numbers (paratypes). K, NSW, and MEL isotypes.

The new species differs from *Bassia uniflora* (R. Br.) F. v. M. in base oblong and more oblique, flat villous leaves and vertical seed. From *B. paralellicuspis* R. H. Anderson in divergent, longer, glabrous spines and shorter villous leaves.

Bassia blackiana E. H. Ising. Specimens from Condiments Plain (near Mount Barry Station), 45 miles south of Oodnadatta, show that the leaves are up to 20 mm. long, sessile by a broad base: fruiting perianth to 4 mm. long, remaining tomentose; spines sometimes only slightly recurved; base oblique, *E. H. Ising*, No. 3583, 13.7.52.

Kochia concava n. sp.

Suffrutex, erectus, 30-40 cm. alt., *caulo* ramisque lignosis, adpresse albo-pubescentibus; *folia* 12-32 x 1·5-3 mm., linearia vel lanceolata, acuta, crassa, sessilia, basi lata, adpresso-sericea, albo-pubescentia, utrinque longitudinaliter costata vel rugosa; *perianthus fructus* concavus, 5-10 mm. diam., ala inclusa, tomento denso albo-lanato intricato abditus; *ala* 2-4 mm. lat., annulata, coriacea, adscendens; *loba* 4-7, inaequalia, irregularia, obtusa; *tubus* convexus, 1-2 mm. long., circa 4 mm. diam.; *basis* parva; *semina* horizontalis, oblonga, plana, brunnea, 2 mm. longa.

Erect *shrub* 30-40 cm. high; *stem* and branches woody, with white silky appressed pubescence; *leaves* 12-32 mm. long, 1·5-3 mm. wide, linear-lanceolate, acute, thick, sessile, attached by broad base, longitudinally ribbed or rugose on both faces, pubescence white, silky appressed; *fruiting perianth* concave, 5-10 mm. diam. including wing, hidden by dense white loose woolly hairs; *wing* 2-4 mm. wide, annular, coriaceous, ascending; *lobes* 4-7, very unequal and irregular, obtuse; *tube* 1-2 mm. long, about 4 mm. wide, convex; *base* small; *seed* horizontal, oblong, 2 mm. long, flat, brown.

Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising*, No. 3561, 3.9.52 fig. 1, 1-5, the holotype consisting of three pieces off the type plant and are covered by the description herewith (NSW isotype). Only one plant seen and collected from. *Holotype* AD.

This new species differs from *Kochia scleroptera* J. M. Black in hairs on branches pubescent; leaves longer and with prominent longitudinal ribs on both faces; fruiting perianth larger and with villous hairs; wing annular and very unequally lobed and tube not ribbed.

Although the new species is almost identical with *Kochia eriantha* F. v. M. in stem, branches, leaves and in the hairs of the fruiting perianth, it differs radically in shape and consistency of the fruiting perianth which is hard and thick; wing concave, ascending, very unequally lobed; in tube convex and seed horizontal.

Kochia ovata n. sp.

Suffrutex, circa 13 cm. alt., ramis paucis plerumque procumbentibus; ramulis lateralibus numerosis, 5-20 mm. long., circa 3 mm. diam., folia et tomento inclusis; planta tota densissime albo-lanata et caulo foliisque abditis; *folia* plerumque 2 mm. long., sessilia, ovata, subconcava, obtusa, integra, conferta, alternata, sursum villosa; *perianthus fructus* 2-3 mm. diam., ala horizontali inclusa, glaber sed loba villosa; *ala* tenuiter membranacea, dilute aurea, circa 0·5 mm. lat., 1-fissa vel irregularis; *tubus* hemisphaericus, circa 1 mm. long., dilute brunneus, nitens; *costae* una vel plures distinctae; *basis* parva, orbiculata, minute concava; *semina* horizontalis, 1 mm. diam., atro-brunnea, nitens.

Small *undershrub* about 13 cm. high, branches few, mostly procumbent; numerous lateral branchlets 5-20 mm. long and 3 mm. thick including leaves and wool; whole plant so densely white woolly tomentose as to hide all stems and leaves; *leaves* usually 2 mm. long, sessile, ovate, somewhat concave, obtuse, entire, closely placed, alternate, villous hairs on upper face; *fruiting perianth* 2-3 mm. diam., including horizontal wing, glabrous except lobes which are villous; *wing* thin, membranous, pale-golden, once cleft, about 0·5 mm. wide, sometimes uneven; *tube* hemispherical, about 1 mm. long, pale brown, shining; *ribs* one with often several others more or less distinct; *base* small, circular, minutely hollowed; *seed* horizontal, 1 mm. diam., dark brown, shining.

Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising,* No. 3563, 10.10.52, fig. I, 10-13, the holotype. The *holotype* (AD.) consists of three pieces off the type plant which are covered by the description herewith. Only one plant was collected from and each piece bears the same number, No. 3563 (NSW isotype). Many other specimens were collected from the type locality in 1954.

Differs from *Kochia enchylaenoides* J. M. Black in leaves ovate and smaller; perianth base smaller, 1-6 ribbed, not turning black and clothing densely woolly. From *K. tamariscina* (Lindl.) J. M. Black in the clothing, leaves and perianth tube.

Malacocera biflora n. sp.

Suffrutex usque ad 25 cm. alt., ramis numerosis, lateralibus procumbentibus, totis albo-tomentosis; *folia* alternata, linearia vel oblonga, acuminata, sessilia, basi lata, villosa, in aetate subglabra, 3-9 x 1·5 mm. (in plantas juvenilibus usque ad 25 mm. longa); *flores* parvuli, bini axillares, in ramis distaliter conferti, dense tomentosi; *perianthus* obtuse paullum 5-lobatus, fructum tegens; *stigmata* 2; *perianthus fructus* planus, circa 5 mm. long., sursum 3·5 mm. diam.; *alae* 3, circa 1·5 mm. long., horizontales, obtusae vel acutae, sumbolles, 2 superioribus corniculatas, ab inferiore late separatas (raro ala quarta lateralis adest); *basis* perianthi orbiculata, centralis, dense radianto-villosa; *tubus* brevissimus, convexus; *semina* horizontalis, biconvexa.

Small *undershrub* up to 25 cm. high; branches numerous, lateral ones procumbent, all hidden by white tomentum; *leaves* linear to oblong, acuminate, villous, more or less glabrous with age, 3-9 mm. long x 1·5 mm. wide (up to 25 mm. long on young plants), sessile with broad base, alternate; *flowers* small, consistently 2 in axils, crowded at top of branches, densely tomentose; *perianth* with 5 small lobes which close over the fruit; *stigmas* 2; *fruiting perianth* flat, about 5 mm. long and 3·5 mm. wide at summit; *wings* usually 3 about 1·5 mm. long, horizontal, obtuse or pointed, more or less soft, the two at the top horn-like in appearance and widely separated from the basal one, sometimes a fourth lateral one; *base* small, circular, central, surrounded by dense villous radiating hairs; *tube* very short, convex; *seed* horizontal, biconvex.

Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising,* No. 3616, 27.10.53, fig. I, 6-9, the holotype. The *holotype* (AD) consists of twelve pieces off the type plant which are all covered by the description herewith. Besides the holotype, I also collected, from the same locality and at the same time, different specimens of the new species and these are given different numbers (paratypes). NSW and MEL isotypes.)

Malacocera was described by R. H. Anderson in 1926, Proc. Linn. Soc. New South Wales, li, 382 and *inter alia* he describes the flowers as solitary in the axils with three horizontal horns on the perianth, but he agrees (in a letter to me) that the new species should be placed in this genus although the flowers are consistently two in the axils and there is sometimes a fourth horizontal wing.

The new species differs from *Malacocera tricornis* (Benth.) R. H. Anderson in flowers always being two in the axils and the flat wings broader and shorter, also in a much larger perianth. *M. tricornis* and *M. biflora* n. sp. grow intermingled with one another on Evelyn Downs.

CRUCIFERAE

Lepidium pseudo-ruderale Thell. Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising,* No. 3452, 5.8.52. First record for Far North.

L. strongylophyllum F. v. M. *Undershrub* up to 25 cm. high, at least biennial, glabrous; *stem* and branches striate, hard and woody, erect, stem at base to 5 mm. diam.; *leaves* obovate, up to 24 mm. long and 14 mm. wide, abruptly tapering into a short petiole of 3 mm., entire, obtuse, thick, rigid, midrib prominent at

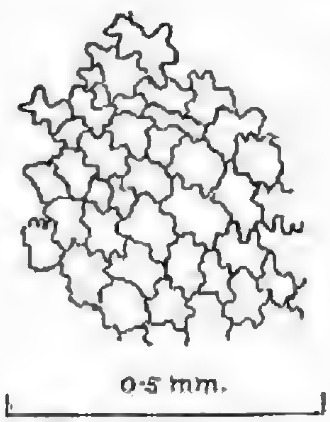
base and decurrent on stem; *racemes* terminal, dense, lengthening in fruit to 10 cm. and persisting on the plant for two or more seasons, a new branch springing from the base of old raceme; *fruiting pedicels* very spreading, 5-6 mm. long, rigid, persistent; *sepals* with white margins, 4 mm. long, oblong, broad at base, keeled at summit; *petals* white, oblanceolate, 5 mm. long, narrowed to base; *pod* almost orbicular, 5 mm. long, 4 mm. wide, valves boat-shaped with narrow wing; *style* 1-2 mm. long; *stigma* capitate, small; *notch* shallow, slightly divergent; *seed* one in each cell, pendulous; *septum* narrow. — Evelyn Downs, 90 miles southwest of Oodnadatta, *E. H. Ising*, 10.10.51, No. 3562. First record for South Australia. Previously recorded from Central Australia and Queensland.

Carinavalva nov. gen.

From Latin *carina*, keel; *valva* valve; the valves of the pod are keeled.

Sepala 4 oblonga, duabus exterioribus basi saccatis; *petala* tenuiter lanceolata, longe acuminata; *stamina* 6 tetradynama; *fructus* brevis latusque, lateraliter compressus dehiscens; *valvis* cymbiformibus, mediis nervis conspicuis; *septo* tenui elliptico, muris cellularum plus minusve quadratarum epidermidis undulatis; *stigma* 2-lobatum; *stylus* brevissimus; *ovarium* sessile bi-cellulare; *ovula* numerosissima; *cotyledones* incumbentes, tenuiter oblongis, compressis, breviter stipitatis. — Herba annua; segmentes folii lineares; flores racemosi, pedunculis nudis.

Sepals 4 oblong, 2 outer ones saccate at base; *petals* narrow lanceolate with long point; *stamens* 6, 4 long and 2 short; *pod* short and broad, compressed laterally, dehiscent; *valves* boat-shaped, midnerve conspicuous; *septum* narrow elliptical, at right angles to greatest diameter of pod, with more or less square-shaped epidermal cells whose walls are wavy; *stigma* 2-lobed; *style* very short; *ovary* sessile, 2-celled; *ovules* very numerous; *cotyledons* incumbent, narrow oblong, flattened, shortly stipitate. — Annual herb; leaves with linear segments; flowers racemose, peduncles naked.



Text Fig. 1

Epidermal cells of septum of *Carinavalva glauca* nov. spec. showing undulate walls. Camera lucida drawing by Miss C. M. Eardley.

This new genus differs from *Cuphonotus* O. E. Schulz in the plant glaucous; petals with a long claw and point; anthers larger, oblong; short style; pod tapering at base; mid-nerve conspicuous on valves of pod; seeds exuding an unbroken mucus when moistened and ovules very numerous. From *Hymenolobus* Nuttall it differs in the plant glaucous; in different leaves, petals and anthers; midnerve on valves of pod not winged; very numerous ovules; the presence of a style and cotyledons stipitate. From *Phlegmatospermum* O. E. Schulz in the plant glaucous; leaves pinnatisect; petals narrow lanceolate; pod bluntly notched; ovules very numerous; seeds very small and cotyledons incumbent. From *Stenopetalum* R. Br. it differs in the plant glaucous; two outer sepals saccate at base; midnerve

conspicuous on valves of pod; stigma 2-lobed; ovules and seeds very numerous. It is very interesting to note that the new genus has the long slender petals of *Stenopetalum*.

O. E. Schulz's monograph(2) on the *Cruciferae* separates the genera into tribes and subtribes and although *Carinavalva* nov. gen. comes near to the tribe Lepidieae it cannot be placed in it at present because the honeyglands have not been satisfactorily observed. Schulz uses this character in his descriptions. These floral nectaries, if present, are extremely small and in spite of much searching they were not clearly seen, but it is believed that each of the two lateral stamens has a pair of minute spur-like glands close together at its outer base. The new genus definitely does not agree with tribe Lepidieae in the epidermal cells of the septum, being more or less square-shaped with undulate walls in *Carinavalva* while in tribe Lepidieae the cells have almost straight walls. It appears that a new tribe is necessary to accommodate the new genus. The characters which are common to *Carinavalva* and tribe Lepidieae are (a) stamens shorter than petals, not sunk in horizontal receptacle and erect, (b) sepals erect, (c) fruit without gynophore, laterally compressed, septum narrow and (d) cotyledons narrow, not folded.

Carinavalva fits into the key in the Flora of South Australia, J. M. Black, 1948, Part II, second edition, 370-1, as follows:—

Siliculosae—

H. Pod broad, compressed.

I. Valves folded and keeled, at right angles to the narrow septum, pod laterally compressed.

L. Cells 2-many seeded.

M. Cotyledons incumbent.

N. Seeds mucose.

NN. Ovules about 140 in ovary, style short, pod obovate, glabrous .... CARINAVALVA

NN. Ovules up to 20 in ovary, style absent.

Pod ovate or oblong, rounded on back and summit, ovules 6-12 in ovary .... CUPHONOTUS

Pod ovoid, rounded at summit, ovules 12-20 in ovary, valves winged .... HYMENOLOBUS

M. Cotyledons accumbent or oblique, ovules 6-12 in ovary, style short, pod ovate, pubescent .... PHLEGMATOSPERMUM

Carinavalva glauca n. sp.

Planta annua, usque ad 30 cm. alt., glabra, glauca, erecta, lateraliIter ramosa; *folia* usque ad 6 cm. longa, pinnatisecta, segmentibus lateralibus 3-6, linearibus, usque ad 20 mm. longis, terminali usque ad 40 mm. longi, obtuso; *racemus* florum

(2) In Engler and Prantl Nat. Pflanzenfam., 1936, 2te Aufl., Bd. 17b, pp. 227-658.

Fig. I, 1-19

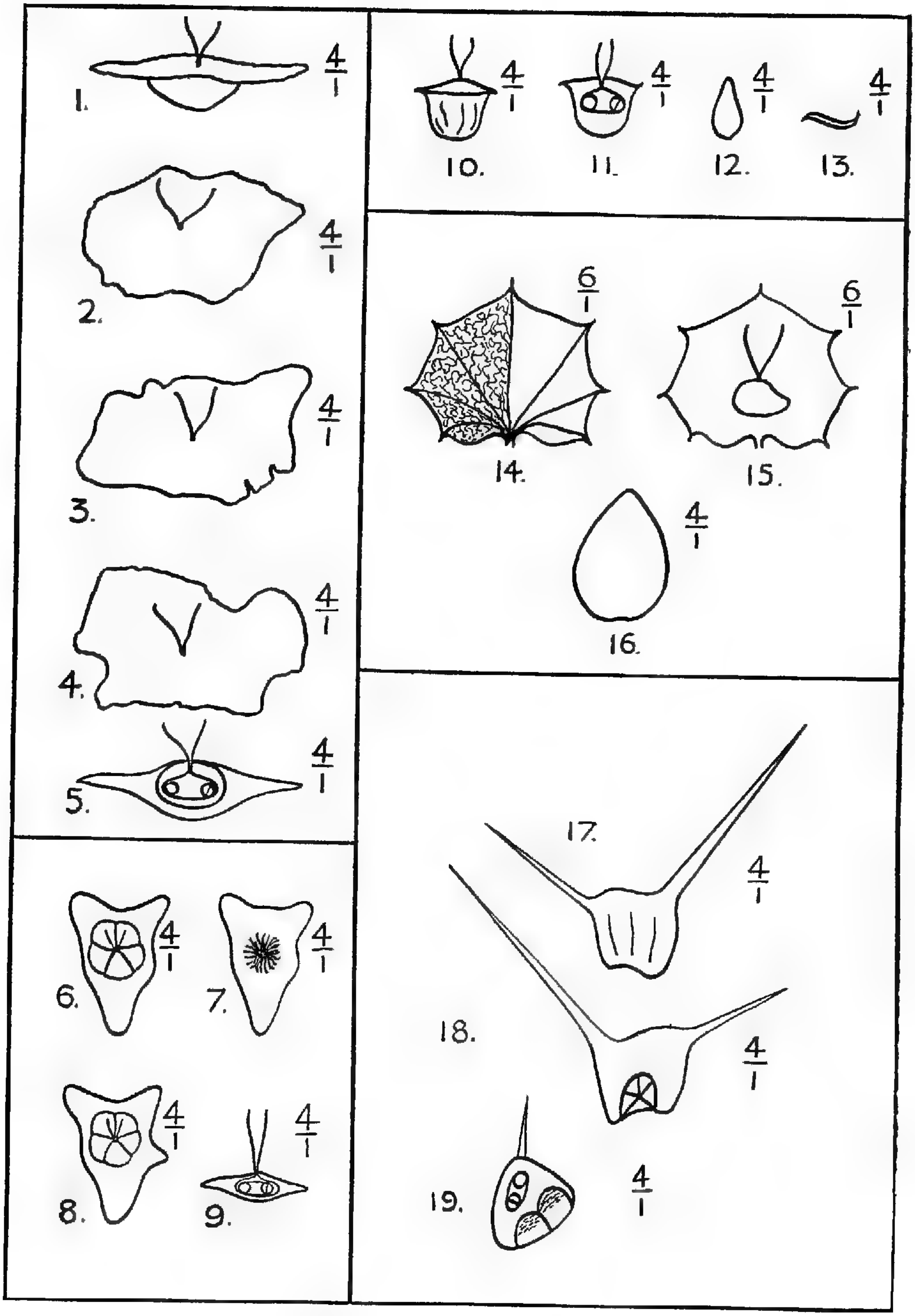
Kochia concava n. sp. No. 3561, fruiting perianths with hairs removed: 1, side view; 2-4, top view; 5, vertical section.

Malacocera biflora n. sp. No. 3616, fruiting perianths with hairs removed: 6 and 8, top view; 7, view from below; 9, vertical section.

Kochia ovata n. sp. No. 3563: 10, side view of fruiting perianth; 11, vertical section of fruiting perianth; 12, top view of leaf with hairs removed; 13, side view of leaf with hairs removed.

Atriplex sessilifolia n. sp. No. 3570: 14, fruiting bracteole showing outer side; 15, inside of fruiting bracteole showing lateral radicle; 16, leaf.

Bassia holtiana n. sp. No. 3624, fruiting perianths with hairs removed: 17, anterior face; 18, posterior face; 19, vertical section.



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terminalis, usque ad 12 cm. longus; pedunculum circa 8 cm. long., erectum; *sepala* 4·5 mm. longa, viridula, albo-marginata, obtusa; *petala* usque ad 15 mm. longa, cremea; *stamina* 4 longa et 2 brevia; *stylus* circa 1 mm. longus; *fructus* obovatus, usque ad 11 mm. longus et 6 mm. latus, apice obtusus vel subincisus, in valvis 2 cymbiformis lateraliter compressus, reticulatus; *pedicellus fructus* circa 5 mm. longus, erectus; *stigma* 2-lobatum; *septum* transversum; *ovula* 2-seriata, circa 70 in valvo uno; *semina* brunnea, oblonga, muco exudentia.

Annual up to 30 cm. high, glabrous, glaucous, erect, with several lateral branches; *leaves* to 6 cm. long, pinnatisect with 3-6 linear segments about 20 mm. long, terminal one up to 4 cm. long, obtuse; *flowers* in a raceme up to 12 cm. long, terminal, peduncle about 8 cm. long, erect; *sepals* 4·5 mm. long, pale green with white margin, obtuse; *petals* up to 15 mm. long, cream; *stamens* 4 long and 2 short; *style* about 1 mm. long; *pod* obovate, up to 11 mm. long, 6 mm. wide, obtuse or slightly notched at summit, compressed laterally into 2 boat-shaped valves, reticulate: *fruiting pedicel* about 5 mm. long, erect; *stigma* usually 2-lobed; *septum* at right angle to valves; *ovules* in 2 rows, about 70 to each valve; *seeds* mid-brown, oblong, exuding mucus. In some flowers the adjacent median filaments were joined in pairs from the base almost to the anthers.

Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising*, No. 3569, 10.9.52, the holotype, fig. II, 1-7. *The holotype* consists of four complete plants (AD.), which were all collected by me in the same locality and at the same time and are covered by the description herewith (NSW isotype). The following specimens of this new species were also collected—6 complete plants, No. 3642, at Evelyn Downs on 2.8.52 (MEL, K, paratypes); 15 complete plants, No. 3643, at Mount Barry Station, 60 miles south of Oodnadatta, owned by Mr. R. D. Kempe, on 26.8.51, these are paratypes and are located in the same place as the holotype.

Leguminosae

Acacia argyrophylla Hook, Kanmantoo, *E. H. Ising*, No. 3407, 15.5.38. A solitary shrub of about 2 m. in height with the typical golden shoots to the branchlets; in bud and young fruit. The most southerly place yet recorded for this species.

Frankeniaceae

Frankenia foliosa J. M. Black. Mount Willoughby Station, 80 miles south-west of Oodnadatta, *E. H. Ising*, No. 3576, 1.8.51. The identification was made at the Royal Botanic Gardens, Kew, England, and is an additional locality for the Far North.

Goodeniaceae

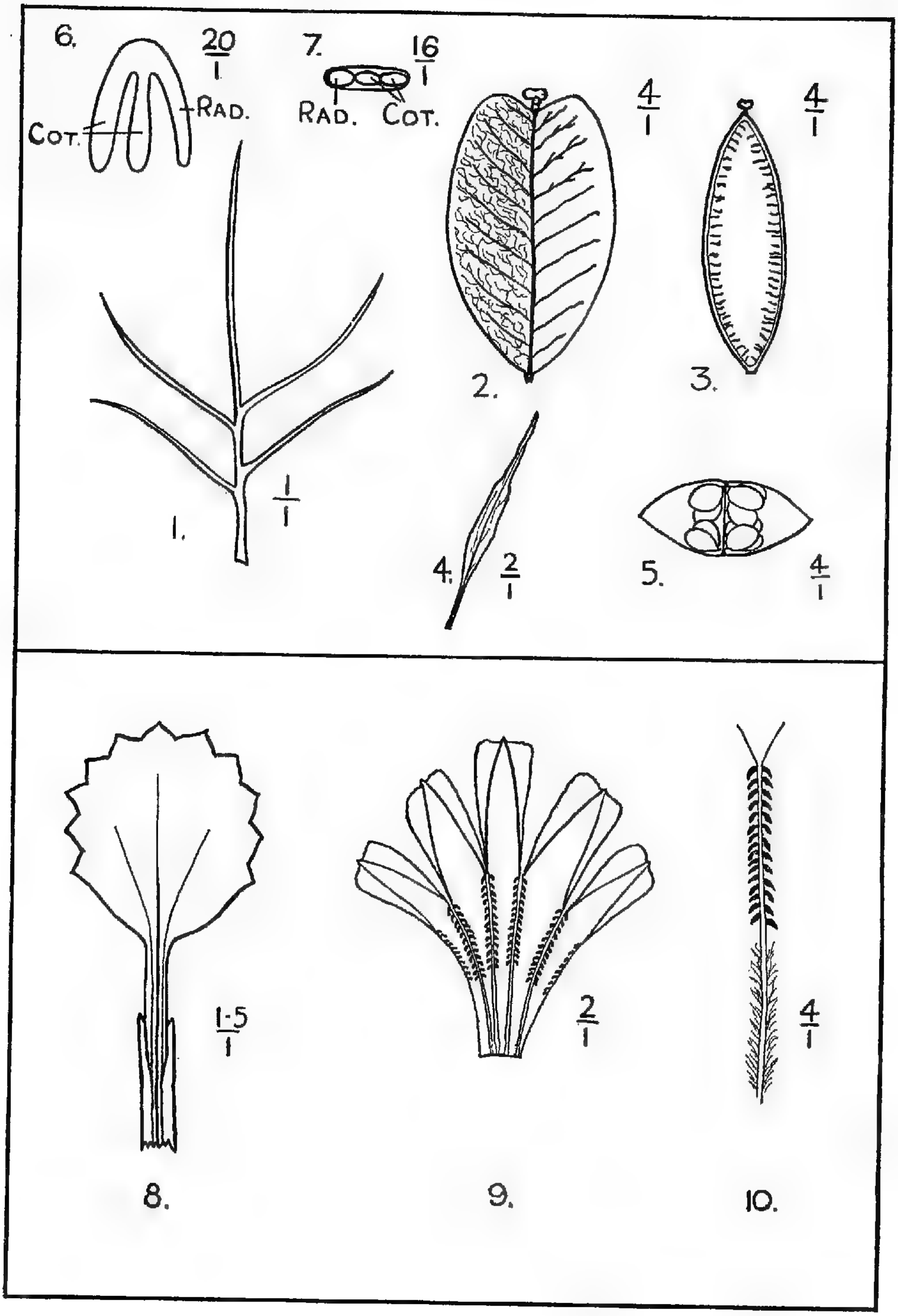
Goodenia helenae n. sp.

Frutex erectus, perennis, 30-40 cm. alt., deorsum lignosus; *caulus* 10 mm. diam.; rami numerosi, costati, subviscosi, pubescenti; *folia* basalia non visa, illas cauli late ovata vel orbiculata, obtusa, pubescentia, margine basi excepta crasse triangulato-dentata, usque ad 50 mm. longa petiolo incl., superiora breviora, nervis totis bilateraliter prominentibus, deorsum nervo medio in petiolo et caulo decurrenti, aliis in petiolo decurrentibus, basi conjunctibus et in caulo costas

Fig. II, 1-10

Carinavalva glauca n. gen. et n. sp. No. 3569: 1, leaf; 2, fruit; 3, septum, showing funicles in one valve; 4, petal; 5, transverse section of fruit showing seeds; 6, embryo, cot. = incumbent cotyledons, rad. = radicle; 7, transverse section of seed, rad. = radicle, cot. = cotyledons.

Goodenia helenae n. sp. Nos. 3626 and 3626A: 8, lower surface of leaf, showing attachment at node; 9, corolla laid open; 10, showing two rows of curved teeth on ribs decurrent from sinus.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lateralia 2 decurrentia efformantibus; *petiolum* usque ad 25 mm. longum; *pedunculum* 1-3 florescens, 2-6 mm. longum, summo bracta linearia 2, 2-4 mm. longa ornatum; pedicellum usque ad 8 mm. longum; bracteola 2, linearia, 2 mm. long., floris 2-3-cymosis bracteolis distantibus; *sepala* lanceolata, pubescentia, 5-6 mm. longa; *corolla* flava, 20-25 mm. longa, haud saccata, extrinsecus pubescens, in tubo villosa et sub sino 2-costata, costis deorsum uni-seriato-dentatis, dentibus acutis desuper curvatis, extus in floris maturis costi prominenti; alae apice obtusae, auriculis nullis; *anthera* apiculata; *stylus* 10-12 mm. longus deorsum villosus, apice post indusium ciliatum expansus pilosusque; *capsula* usque ad 12 mm. longa, obovoidea, septo circa 5 mm. longo; *semina* 15-20, oblonga, circa 4·5 mm. longa et 3 mm. lata, concava, pallida, punctulata, tenuiter marginata.

Shrub erect, stout, perennial, 30-40 cm. high, with woody base; *main stem* about 10 mm. thick, lateral branches numerous, ribbed, somewhat viscid, pubescent; radical *leaves* not seen, stem leaves broad-ovate to orbicular, obtuse, pubescent, coarsely triangular toothed except at base, up to 5 cm. long including petiole, becoming smaller upwards, nerves prominent on both faces including marginal one, on lower surface midrib decurrent on petiole and stem, lateral and marginal nerves decurrent on petiole and joining at its base to form a decurrent rib on stem, one on either side of midrib; *petiole* up to 25 mm. long; *peduncles* 1-3-flowered, 2-6 mm. long with 2 linear bracts 2-4 mm. long at summit, pedicels to 8 mm. long with 2 linear bracteoles 2 mm. long distant from the flower when there are 2-3 flowers in a cyme; *sepals* 5-6 mm. long, lanceolate, pubescent; *corolla* yellow, 20-25 mm. long, not pouched, pubescent outside, villous in tube and 2 ribs decurrent from sinus with a row of acute downward curved short teeth on each in lower half, ribs prominent on outside of mature flowers, wings broad at summit, auricles absent; *anthers* apiculate; *style* 10-12 mm. long, villous in lower half, a tuft of hairs at its expanded summit at back of indusium which is ciliate at summit; *capsule* to 12 mm. long, obovoid, dissepiment about 5 mm. long; *seeds* 15-20, oblong, about 4·5 mm. long and 3 mm. wide, concave, pale, punctulate, rim narrow.

Evelyn Downs, 90 miles south-west of Oodnadatta, *E. H. Ising*, No. 3626, 15.9.50, fig. 11, 8-10, the holotype; No. 3626A, 15.10.50 the paratype. *Holotype* and *paratype* (AD.). The holotype consists of 9 pieces off the type plant (NSW, MEL, K, isotypes), and the paratype consists of 13 pieces off the type plant (MEL, K), and both are covered by the description herewith. Both the holotype and the paratype were collected in the same locality but on different dates, the latter was chiefly used for the description of the ripe fruits.

The new species is named in honour of my daughter (Mrs. R. G. Holt of Evelyn Downs). It was only found growing in loose stones and rock at the base of an 8-foot cap of almost solid rock persisting on the flat-topped ranges about 100 feet above the surrounding plain.

It differs from *Goodenia rotundifolia* R. Br. in being a stout erect woody shrub, well branched; petioles not tapering; peduncles stout, much shorter than stem leaves, bracteoles distant from flowers; larger flowers, no auricles; style longer, villous in lower half, indusium hair-tufted at back; capsule longer. From *G. grandiflora* Sims in being a stout woody perennial; simple leaves and petioles; corolla without protuberance, villous in tube; style glabrous in upper part; capsule obovoid, seeds concave, punctulate. From *G. decurrens* R. Br. in stems leafy all over; in the clothing; leaves smaller; indusium with tuft of hairs at back; capsule larger, seeds concave, margin thin.

Compositae

Calotis breviradiata (E. H. Ising) G. L. Davis. This plant was described by me (1922, Trans. Roy. Soc. South Australia, 46, 608) as a variety of *C. multicaulis* (Turcz.) Domin and has now been raised to specific rank by Dr. G. L. Davis,

1952, Revision of the genus *Calotis* R. Br., Proc. Linn. Soc. New South Wales, 77, (3-4), 186. It is a rare species, only recorded in this State on the Nullarbor Plain at Watson and Hughes and at Eucla in West Australia.

**Osteospermum calendulaceum* L. f. (*Oligocarpus calendulaceus* Less.); tribe Calenduleae. Annual, stems many from the crown, at first ascending, then diffuse, procumbent or trailing, much branched and widely spreading, pubescent and glandular, as well as the leaves; young parts cobwebby. Leaves alternate, 1-2 inches long, 4-10 mm. wide, tapering at base or subpetiolate, oblong or lanceolate, irregularly few-toothed, repand or subentire, the upper small, sessile, linear. Pedicels terminal and axillary, one-headed. Heads small, few flowered. Involucral scales lanceolate, acute, variably membranous-edged. Achenes of many forms, on the same plant or in the same head: 1. very much pitted and ridged across, obconical, crowned with an inflated hollow cup-like beak; 2. slightly wrinkled with a similar beak; 3. very much cross-ridged and beakless or nearly so; 4. scabrous, but scarcely wrinkled, with an obsolete beak; 5. scabrous or smooth, terete or 3-cornered, with a long, horn-like, solid beak; 6. 3-cornered, the angles minutely winged; 7. cross-ridged and furrowed, with three membranous wings, exactly as in *Tripteris*. Hab.—Cape Colony, South Africa. (Taken from the description by Harvey, 1864-5, Flora Capensis, 3, 433.)

Port Augusta, *E. H. Ising*, No. 3585, 22.10.52. This is the first record of this plant for South Australia. Identified by the Chief, Div. of Botany, Dept. of Agriculture, Pretoria, Union of South Africa, who reports:—"Tycho Norlindh working on the Calenduleae has sunk the genera *Tripteris* and *Oligocarpus* in *Osteospermum*, and we have arranged our herbarium accordingly. Studies in the Calenduleae I, Monograph of the genera *Dimorphotheca, Castalis, Osteospermum, Gibboria* and *Chrysanthemoides*. By Tycho Norlindh, 1943."

O. clandestinum (Less) Norlindh, 1943, loc. cit., 328 (*Tripteris clandestina* Less.). This change of name is necessary as Norlindh has sunk *Tripteris* in *Osteospermum*. Recorded already from fields near Brighton and Marino.

Senecio pterophorus DC. Crafers and Stirling (Mount Lofty Range), *E. H. Ising*, No. 3623, January to March, 1954. Identified by the Chief: Div. of Botany, Department of Agriculture, Pretoria, Union of South Africa. This introduction is spreading in the above district and could become a pest. It seeds prolifically, germinates readily and quickly occupies cultivated land. It is a perennial growing up to 3 m. in height and has already been recorded in this State.

Acknowledgments

I wish to acknowledge with thanks very helpful criticism and suggestions, as to some of the species, from Mr. R. H. Anderson, B.Sc. (Agr.), Chief Botanist and Curator, Botanic Gardens, Sydney; Mr. A. W. Jessep, Director and Government Botanist, Melbourne Botanic Gardens and National Herbarium; Dr. J. G. Wood, Professor of Botany, for permission to use the herbarium under his control and Miss C. M. Eardley for much technical assistance and communicating the paper, both of Botany Department, University of Adelaide; Dr. C. G. Hansford, Waite Agricultural Research Institute, Glen Osmond, for composing the Latin descriptions; and Miss L. Sherwood, Botany Department, University of Adelaide, for executing the drawings.

THE "GRAND" UNCONFORMITY BETWEEN THE ARCHAEAN (WILLYAMA COMPLEX) AND PROTEROZOIC (TORROWANGEE SERIES) NORTH OF BROKEN HILL, NEW SOUTH WALES

*BY R. B. LESLIE AND A. J. R. WHITE**

Summary

A structural and petrological study has been made of a small portion of the unconformity between the older Precambrian (Willyama complex) and the later Precambrian (Torrowangee Series). A true angular unconformity has been recognized but post-Torrowangee folding and shearing has in places complicated this primary feature.

The Willyama rocks are a complex of metasediments, cataclastic schists and pegmatites, which has been intruded by a leucocratic muscovite granite-the Mundi Mundi granite. The sediments of the Torrowangee Series are of glacial origin. The basal beds of this glacigene series are notable in that they contain for the most part material derived from the immediately underlying rock. This has given rise to some peculiar rock types such as granite tillites and slate tillites.

Petrological studies made on the Torrowangee sediments and the boulders contained in them, as well as on the rocks of the Willyama complex give indisputable evidence of the pre-Torrowangee age of the Mundi Mundi granite. The Torrowangee sediments have in places been highly folded with some local dynamic metamorphism but in the area studied at least, there is no evidence of post-Torrowangee igneous activity.

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INTRODUCTION

(a) Location

The area is situated 26 miles due north of Broken Hill in the Barrier Ranges of New South Wales (fig. 1). It comprises some 15 square miles covering the unconformity between the Torrowangee Series and the older rocks of the Willyama complex.

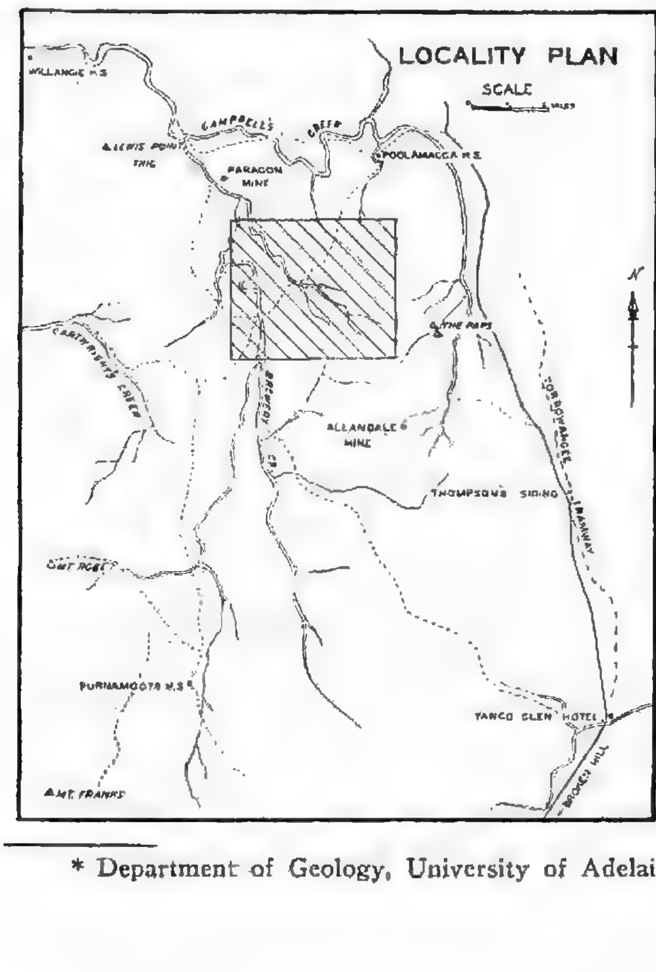

Fig. 1
Locality plan showing principal landmarks in the area. A geological map of the hatched area is included in this paper.

* Department of Geology, University of Adelaide.

(b) Physiography

The area is one of low hills usually sparsely covered by a typically semi-arid vegetation consisting predominantly of mulga (*Acacia aneura*), dead finish (*Acacia tetragonophylla*) and beefwood (*Grevillea striata*), together with the ever-present saltbush. The hills of the area fall naturally into three well-defined groups. Jagged, craggy ridges in the schist area stand up in marked contrast to the rounded boulder-strewn hills of tillite and the pale tor-covered hills of granite.

Because of the paucity of vegetation and a general lack of soil cover the rock outcrops are usually particularly good.

The country is well dissected by numerous streams, the largest of these being the Brewery and the Wookookaroo Creeks. These streams, like others in the Barrier Ranges, are not permanent but flow only after heavy rains. However, deposits of water-bearing sands along their seemingly dry beds support large red gums which give welcome relief from the scant vegetation of the hills.

(c) Previous Investigations and Scope of Present Work

The first major contribution to the regional geology of the Barrier Ranges was published by Mawson in 1912. He recognised the unconformity between the Willyama complex and the Torrowangee Series and correlated the latter with the Adelaide System of South Australia. Mawson published an analysis of a younger pre-Torrowangee granite (*vide* p. 126), which he called a "protogine granite." The Geological Survey of New South Wales, Andrews and his associates, published a monumental work on the geology of the Broken Hill district in 1922, and although this work contributed much to the regional geology it was particularly concerned with the lode and its immediate environment. Andrews used the time terms Archaean and Proterozoic for the Willyama complex and Torrowangee Series, respectively. He also termed the "Newer" or "Protogine" granite of Mawson, the Mundi Mundi granite. These terms are retained in this paper.

In 1953 King and Thomson published an account of the regional geology of the Broken Hill district. Their map, the culmination of many years of field mapping by geologists of the Zinc Corporation, far exceeds the previous sketch maps in accuracy and detail. An outcome of this recent work was the proposed post-Torrowangee age of the Mundi Mundi granite. They also suggested that some of the pegmatites of the region post-dated the Torrowangee Series.

The present investigation is an attempt to elucidate the complexities of the unconformity and to fix the relative age of the pegmatite and the Mundi Mundi granite.

STRATIGRAPHY

The basal rocks of Archaean age are part of the Willyama complex. They are overlain unconformably by a series of late-Proterozoic sediments, the Torrowangee Series, which has been correlated with the Sturtian Series of the Adelaide System. There is no evidence of marine sedimentary deposition since Pre-cambrian time.

The Willyama rocks were folded, metamorphosed, intruded and eroded before the Torrowangee sediments were deposited upon them with marked unconformity. In places the unconformable contact is masked by shearing, but elsewhere it is well shown. Exposures in the vicinity of Brewery Well show a marked angular unconformity, the strikes of the older and newer beds being almost at right angles. Where the unconformity trace swings southward on the eastern side of the area, metamorphic convergence due to shearing has in places caused the exact demarcation of the unconformity to become difficult.

THE WILLYAMA ROCKS

The term Willyama complex was first applied by Mawson (1912) to the extensive tract of ancient rocks outcropping in the Barrier Ranges of New South Wales and the adjacent areas in South Australia. These rocks, which were originally a series of argillaceous, arenaceous and calcareous sediments, now appear as a complex of schists and gneisses due to intense pre-Torrowangee metamorphism.

The highest grade of metamorphism occurs in the vicinity of Broken Hill itself, as evidenced by the abundant development of sillimanite in this region. The grade of metamorphism, however, decreases to the north, so that in the area under investigation the rocks are of low grade, normally not exceeding the green-schist facies.

(a) The Fine-grained Metasediments

The metasediments are dominantly very fine-grained arenaceous and argillaceous schists, sometimes finely laminated, together with graphite "chiastolite" phyllites and thin-bedded chert-like rocks.

The chert-like rocks are extremely fine-grained (average ·04 mm.). Although they have a superficial resemblance to chert it is probable that they had a clastic origin and are therefore better described as meta-siltstones. Their colour varies from pure white to buff and almost black and many are flecked and banded. They consist essentially of a recrystallized aggregate of quartz with subordinate plagioclase (Ab 90). Flakes of green biotite and muscovite vary in amount, while tourmaline, zircon and iron ores are accessory. A feature of many is the abundance of small black graphite inclusions in almost all of the minerals. Near the granite, the graphite although less abundant, occurs as segregations up to 1 mm. across, suggesting that the metasiltstones have been somewhat modified by the granite intrusion.

The other fine-grained metasediments of this area differ from these chert-like rocks in the increased amount of argillaceous material originally present in the sediments; this is now represented by sericitic micas. The relative amount of sericite and quartz varies up to the stage where sericite becomes the main constituent of the rock.

Tourmaline has a wide distribution throughout all the metasediments. Usually it occurs as an accessory but at times it becomes an important constituent.

From the unconformity, at a point about 1 mile E.S.E. of the Brewery Well stockyards, thence continuing to the south, there occurs a distinctive formation up to 1,000 feet thick of dark, bluish-grey phyllites and fine-grained arenaceous schists which contains abundant but completely altered metacrysts of chiastolite (9625).[1] The metacrysts are square-shaped in cross section and often display the zoning so typical of chiastolite. They are normally ½ inch across, but some, especially those in the more arenaceous beds, are up to 1 inch across and 5 to 6 inches in length. When examined under the microscope the chiastolites are seen to be entirely replaced by an aggregate of fine sericite. Both the dark colour of the matrix and the zoning of the metacrysts is the result of abundant finely-disseminated graphite.

This rock is very similar to the chiastolite phyllite described by Browne (1922) from Mount Franks, some 15 miles further south. In the case of the rock from Mount Franks, however, some andalusite was recognised in the thin section.

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[1] The specimen numbers referred to in the text are those of the Rock Catalogue, Department of Geology, University of Adelaide.

What appears to be the same stratigraphical horizon somewhat modified occurs in contact with the Brewery Creek pluton (an intrusion of the Mundi Mundi granite) on its southern and western sides. Here the rock (9668) is dark-grey in colour and the "chiastolites" are only about ½ to 1 mm. across and 1 cm. in length. Ill-defined spots several millimetres across consisting of aggregates of biotite and muscovite are also present. The rock consists of pseudomorphs after chiastolite, irregular segregations of biotite and large poeciloblastic muscovite crystals in a fine-grained matrix of quartz, sericite, biotite and abundant graphite. Iron ore (haematite) and tourmaline are also present. The chiastolite pseudomorphs, appear as square-shaped aggregates consisting either of quartz poeciloblastically including fine sericite or of small muscovite flakes. Usually the boundaries of the pseudomorphs are sharp, particularly when quartz is the secondary mineral. At times the cross sections are seen to be divided into four segments by the diagonals of the square and each of these segments seems to be separately replaced, giving the appearance of a twinned crystal (pl. IX, fig. 1 and 2). Quartz, apart from the large crystals replacing the chiastolites, occurs abundantly in the matrix as tiny xenoblastic crystals averaging ·02 mm. in size. This recrystallized quartz is crowded with graphitic inclusions. Muscovite is also present as fine-grained aggregates and as larger poeciloblastic flakes averaging ·25 mm. in length. Biotite is not as abundant as muscovite. It occurs mainly in segregations about 2 mm. across showing decussate structure. It is also present together with muscovite and quartz in the chiastolite pseudomorphs, but in this case the pseudomorphs are irregular and not clearly defined. The biotite is a greenish-brown variety, X = pale brown, Y = Z = dark brownish-green. Hematite and graphite are abundant as small black opaque grains, while tourmaline is accessory.

The "chiastolite" phyllites occurring near the southern margin of the Brewery Creek pluton may have been formed by the thermal metamorphism of the granite itself and then replaced, in the manner described above, by late stage metasomatic activity. However, field evidence suggests that the chiastolites were formed on a regional scale prior to the intrusion and then later locally modified by the intrusion; the "chiastolites" occur in well-defined sedimentary bands and are developed on a regional scale in places often remote from granite.

(b) The Dynamically Metamorphosed Willyama Rocks

The coarse-grained quartz-mica schists and micaceous quartzites which outcrop in the eastern portion of the area contrast sharply with the finer-grained schists to the west, both petrographically and in their manner of outcrop; the coarse-grained schists outcrop as jagged razor-back crags which often contain open holes commonly a foot or more across.

All of the schists have a marked cataclastic texture and consist of quartz muscovite and chlorite. In some of the finer-grained varieties the structure seen in this section is almost mylonitic. Streaks and bands of sericitic material alternate with bands consisting dominantly of quartz. About one mile west of the Paps some of the schists examined contain an abundance of biotite and occasionally pink garnet.

(c) Basic Rocks

An amphibolitic rock has been mapped within the great pegmatite mass near Pollard's Well. This has not been examined in great detail, but the field and laboratory work suggest a metasedimentary origin.

(d) The Pegmatites

Other authors refer to the great development of these rocks in the Willyama complex of the Barrier Ranges. Mawson (1912) says: "In no other part of the world can pegmatite formations occur on a more extensive scale."

To the south of Pollard's Well occurs a mass of pegmatite more than half a mile wide.This mass is intimately mixed with country rock, particularly at the margins, and is traversed by cross-cutting dykes of the granite from which it is easily distinguished both in the field and in the laboratory. From these cross-cutting relationships it is inferred that the pegmatite pre-dates the granite, and, although some pegmatite may have been associated with the granite, there is no evidence to support this. Apart from this large mass several smaller masses occur, while dykes are very abundant. Where the dynamic metamorphism has been more intense the dykes are usually parallel to the schistosity, whereas elsewhere the dykes tend to follow the bedding. At times the pegmatites show evidence of shearing at their peripheries, and in at least one case a pegmatite has been completely sheared out. Although dykes of pegmatite quite commonly extend to the unconformity, they are never found in the adjacent Torrowangee rocks, suggesting that in this area, at least, all pegmatites are pre-Torrowangee in age.

The pegmatite is usually very coarse-grained with felspars up to 3 inches across. The average composition of the pegmatites is about 60% felspar (both albite and microcline) and 40% quartz. Accessory minerals include muscovite, garnet and tourmaline. Magnetite occurs rarely. Reddish-brown garnet which is widely distributed occasionally becomes an important constituent, sometimes making up about 10% of the rock. Usually it occurs as rhombic dodecahedrons, occasionally as icositetrahedrons, and is up to half an inch across. An approximate analysis of some of this garnet gave 10% MnO.

In the field all stages from felspar-rich pegmatites to quartz reefs are seen, although the intermediate stage is usually more of the nature of a composite "intrusion" of quartz within pegmatite. Tourmaline occurs sporadically in most of the pegmatite, but seems to be concentrated in some of the quartz reefs.

The general abundance of pegmatites, together with the great size and shape of the Pollard's Well mass, suggest that the pegmatite has a replacement origin. This hypothesis is supported by the fact that the foliation of the patches of relic schist within this mass is parallel to the foliation of the schists occurring elsewhere in the area.

(c) The Granite

Post-dating the schists and pegmatites of the Willyama complex is an intrusive leucocratic granite, the Mundi Mundi granite (Andrews and Browne, 1922).

Apart from the main mass of granite which has been termed the Brewery Creek pluton, other smaller masses outcrop along the upper reaches of the Wookookaroo Creek. These masses are more or less continuous and have been considered by King and Thomson (1953) to be an extension of the "dyke" which extends from Yanco Glen to north of the Paps along the general trend of the unconformity.

The northern extremity of this "dyke" has been studied, and no evidence can be found in this locality at least to suggest a dyke-like origin. Rather, it seems to be part of the irregular roof of a larger granite mass below. This is supported by the fact that the intrusive contact between the granite and the steep-dipping schist is seen in places to be almost horizontal. The trace of the granite-schist contact often follows the contours around the valleys running into the main creek, thereby suggesting that it is flat. The present elongated outcrop appears to be due to the creek cutting through this flat contact and exposing the granite.

Numerous smaller masses and dykes of the same granite are widely distributed throughout the eastern part of the area. These dykes, which are usually very thin, commonly follow the schistosity. One such dyke only two feet wide

was followed along the foliation for about three-quarters of a mile. The abundance of these smaller occurrences is also suggestive of the proximity of a larger granite mass below.

The typical granites are leucocratic rocks in which the percentage of mafic minerals rarely exceeds 4%. They are characterised by a high percentage of muscovite and by a slight excess of plagioclase over microcline. The plagioclase always has a composition approaching pure albite. According to the Shand classification, these are per-aluminous sodi-potassic granites, while they compare closely with the alaskites of Johannsen (1932) (*vide* Table I, Column V).

Towards the centre of the Brewery Creek pluton the granite is medium to coarse in grain size, but elsewhere it is comparatively fine-grained. The granite is stressed to the extent of producing undulose extinction in the quartz, with some granulation at the edges of grains, but nowhere is any visible gneissic structure developed.

The coarse-grained granite (9672) from the Brewery Creek mass is pale pinkish-grey. The approximate mineral composition is quartz 30%, plagioclase (Ab 95) 30%, microcline 25%, muscovite 10%, and biotite 5%, with tourmaline, apatite, and zircon accessory. Both felspars are cloudy, the plagioclase usually more so than the microcline. An interesting feature which is seen in all thin sections of the Mundi Mundi granite from the area, is the abundant development of small laths of colourless mica within the plagioclase crystals. These inclusions are also occasionally seen in the microcline. The quartz often contains strings of fine inclusions and numerous hair-like rods. A chemical analysis of this rock is given in Table I, Column I.

TABLE I

	I	II	III	IV	V
SiO_2	74·07	73·08	74·50	72·60	75·05
Al_2O_3	14·77	14·78	13·72	15·99	13·48
Fe_2O_3	0·51	0·67	0·60	0·34	0·84
FeO	0·46	0·79	0·90	0·78	0·63
MgO	0·16	0·28	0·44	0·20	0·21
CaO	0·51	0·55	0·52	0·38	0·24
Na_2O	3·89	4·35	3·45	4·30	4·20
K_2O	4·43	4·17	5·13	4·36	5·03
H_2O-	0·15	0·24	0·18	0·05	0·34
H_2O+	0·70	0·77	0·26	1·15	
TiO_2	0·19	0·24	0·17	0·13	0·03
P_2O_5	0·10	0·11	0·27	0·14	0·08
MnO	0·01	0·01	0·03	0·03	0·04
BaO	—	0·02	0·05	—	—
ZrO_2	0·03	0·01	—	—	—
S	0·03	—	—	—	—
Others	—	—	0·11	—	0·03
	100·01	100·07	100·35	100·45	100·20

I. Mundi Mundi Granite from Brewery Creek pluton, S. of Poolamacca, Barrier Ranges, N.S.W. Analyst: R. B. Leslie

II. Mundi Mundi Granite from Wookookaroo Creek, S. of Poolamacca, Barrier Ranges, N.S.W. Analyst: A. J. R. White

III. Mundi Mundi Granite, N.W. of Paps, Barrier Ranges, N.S.W. Analyst: J. C. H. Mingaye

IV. Soda-Potash Granite, E. end Binberrie Hill, S.A. (Boolcoomata granite). Analyst: W. S. Chapman

V. Average of three typical alaskites — Johannsen, 1932.

A specimen typical of the fine-grained granite in the smaller outcrops (9671) was collected from the Wookookaroo Creek about two miles east of Brewery Well, and was chemically analysed for comparison with the coarse-grained granite from the pluton. This granite is comparable with the coarse-grained granite in every detail except the grain size. Apart from the mineralogical similarity, the chemical similarity is at once apparent in a comparison of the norms quoted below.

Norm of Brewery Creek Granite		Norm of Granite from Wookookaroo Creek	
Quartz	32·88	Quartz	33·30
Orthoclase	26·22	Orthoclase	24·56
Albite	33·38	Albite	36·82
Anorthite	1·67	Anorthite	2·05
Corundum	2·86	Corundum	2·45
Hypersthene	0·73	Hypersthene	1·23
Magnetite	0·69	Magnetite	0·92
Ilmenite	0·30	Ilmenite	0·30
Apatite	0·23	Apatite	0·24
Pyrite	0·09	Pyrite	—
Zircon	0·04	Zircon	0·02
Water	·85	Water	1·11

From this study it is evident that the two granites are comagmatic. The analyses also show close similarities with a phase of the Boolcoomata granite of South Australia which is probably part of the same Precambrian petrographic province (Table I, Column IV).

Although the granite is normally fairly uniform in composition, certain local variations occur. This is usually reflected in the colour of the rock, which varies from pale grey to pinkish-grey and dark grey. These variations are due to the varying proportions of microcline and albite, the presence or absence of tourmaline, and the relative amounts of biotite and muscovite.

Apart from a zone of felspathization two inches or so wide at the immediate contact and the replacement of the chiastolite in the "chiastolite phyllite" (*vide* p. 124), there is very little evidence of contact metamorphism. However, several aplite dykes were observed both in the granite and the adjacent country rock on the south side of the Brewery Creek pluton.

The maximum extent of thermal metamorphism is seen in the roof pendants and xenoliths of fine-grained biotite muscovite hornfels which are abundant at the northern end of the Brewery Creek pluton. All the xenoliths have a definite lithological resemblance to the fine-grained Willyama rocks immediately to the south of the pluton. The difference is chiefly in the microfabric; the micas in the xenoliths show a lack of preferred orientation, while those in the schist often have a very pronounced orientation.

THE TORROWANGEE SERIES

The existence of a thick sequence of glacial and fluvio-glacial sediments on the northern and north-eastern extension of the Barrier Ranges was first reported by Mawson (1912). These rocks which overlie the Willyama complex with violent unconformity he termed the Torrowangee Series, and from their characteristic lithology they have been correlated with the Sturtian Series of the Adelaide System of South Australia (Mawson 1949).

The Torrensian Series of the Adelaide region is here absent, and coarse boulder beds or sometimes massive quartzite or silicified tillite mark the beginning of the Later Precambrian sedimentation. The following stratigraphic succession is given by King and Thomson:

1. Claystone with massive coarse-grained quartzite.
2. Cleaved shales or claystones with tillite horizons.

3. Limestone lenses in calcareous shales with minor glacial erratics.
4. Flaggy sandstone and laminated shales with minor glacial erratics.
5. Tillite and glacial boulder beds, with massive quartzite and conglomerate close to the base of the series in a number of places.

This paper is only concerned with the basal formation.

The siliceous bed, which forms the base of the Torrowangee Series in much of the Barrier Range region (Basal quartzite of Mawson and Andrews) is underlain by a considerable thickness of glacigene sediments in the vicinity of Brewery Well. The thickness of sediment below this "basal quartzite" is probably of the order of 2,000 feet, although the lens-like nature of the beds and complicated folding makes an accurate determination difficult.

These underlying beds are formed by overlapping deposition, possibly in a glacial valley during the early stages of glaciation.

(a) Lithology

In the area under investigation the "basal quartzite" horizon is represented by arenaceous tillite which often contains large numbers of siliceous blue-grey quartzite erratics and interbedded grits. As the underlying beds decrease in thickness this horizon become silicified and produces in places a dense quartzite tillite which consists essentially of boulders of quartzite in a quartzite matrix.

Although intercalated stratified lenses of greywacke (grits) and slate occur, the beds are in general completely unsorted. The size range is extreme, varying from the finest rock flour up to boulders 12 feet across. Angular, sub-angular and sometimes faceted boulders are present, but the majority of the coarser detritus is comparatively well rounded. This is in conformity with the well-rounded material forming the terminal moraines of some present-day glaciers.

Pressure grooving in the form of sub-parallel markings is occasionally seen on the surface of boulders, but none which could be accepted as genuine glacial striae were found. However, Mawson (personal communication) reports glacial striae on a pebble found near Yanco Glen.

Many of the boulders are of local origin, particularly in the beds lying stratigraphically below the "basal quartzite" horizon. These include most of the rock types occurring in the nearby Willyama complex, namely chiastolite phyllite, flecked and banded metasiltstones, fine-grained quartz-mica schists, pegmatites, and most abundant of all fine, medium and coarse-grained granites. A number of these granite boulders were sectioned and examined under the microscope. They were seen to be identical with the locally occurring granite, thus giving evidence in support of a pre-Torrowangee age for its intrusion. Boulders foreign to the area (true erratics) are less abundant in the lower beds, but become more important higher up in the series. Of these a dense blue-grey quartzite is the most conspicuous.

It is considered that the lowest beds are the result of the action of local land ice; this explains the abundance of boulders of the immediately underlying rock. Higher up in the series, where the beds become more continuous, it is probable that deposition took place under water.

The base of the Torrowangee Series in the area studied, consists for the most part of coarse boulder beds locally sheared but not silicified as is general along the Yanco Glen—Paps line. Occasionally a band of arkosic grit, normally only a few feet thick, can be seen resting on the Willyama schist.

Perhaps the most interesting basal rock is that seen resting directly on the eroded surface of the Brewery Creek granite. This rock has been termed a "granite tillite" as it consists almost entirely of granite boulders in an arkosic matrix, pl. IX, fig. 3). The unweathered rock (9682) is pale grey in colour and typically unsorted. Angular, sub-angular and rounded fragments showing great

variation in size are set in a pale grey base of fine rock flour. Most of the larger fragments are of granite and many of the smaller individual and composite grains of quartz and felspar have been derived from the grinding up of the underlying granite. Fragments of fine-grained slaty and chert-like rocks of the Willyama complex are present but less abundant.

Because of the preponderance of granitic material the weathered surface of the rock, as seen outcropping in the field, shows a marked resemblance to the adjacent granite. In thin section the unsorted nature of the rock is most apparent. Angular and sub-angular fragments vary in size down to minute particles (pl. IX, fig. 4). Fragments of granite contain quartz, microcline, plagioclase, muscovite and tourmaline. Quartz is the most abundant of the individual grains and this often shows the thin hair-like rods which are common in the quartz of the local granites. Felspar fragments consist of both microcline and albite. Small angular grains of tourmaline and scattered throughout the rock, while detrital flakes of muscovite are rare. The fine-grained base contains smaller particles of the material which forms the larger fragments together with abundant sericite which has been derived from the decomposition of felspar.

Tillite occurring near the unconformity in the vicinity of Brewery Well differs from the granite-tillite just described in that the majority of the rock fragments have been derived from the Willyama metasediments, mainly fine-grained metasiltstone.

It is noticeable that the lithology of the tillites in most of the area varies sympathetically with the nature of the underlying parent rock. This is particularly evident with the "granite-tillite" and the tillite consisting predominantly of fine-grained metasiltstone. Another variation is what may be termed a "slate-tillite." This rock consists mainly of slate fragments together with subordinate fragments of granite and quartz. The platy phenoclasts of dark grey slate have a common orientation which is probably due to their tabular nature at the time of deposition. This gives the rock a sheared appearance, unlike the adjacent tillite in which the phenoclasts are equidimensional. This sympathetic variation of tillite with the underlying rock has been observed elsewhere in the Barrier Ranges. Kenny (1934, p. 43) described an "augen gneiss" tillite outcropping on the Euriowie road some 12 miles due east of Poolamacca. He says, "Here the tillite is composed entirely of angular fragments of augen-gneiss so closely set that very little matrix is visible to the naked eye. On first sight the rock has the general appearance of a mass of augen-gneiss, but close study reveals the irregular and conflicting alignment of the folia in the gneissic fragments." Andrews (1922, p. 65) described a tillite rich in quartz magnetite boulders from the Sisters locality near Broken Hill. He also pointed out that "granite waste cemented with tillite material" occurs at the unconformity near Poolamacca homestead.

Above these basal beds are subaqueous glacigene sediments similar to those of the Sturtian Series of South Australia. These consist of interbedded and lens-like occurrences of tillites, greywacke type grits, washed arkosic grits, slates and shales.

The glacigene sediments interbedded with the massive tillites occur as small discontinuous beds normally only a foot or so in thickness, which lens out over a distance rarely more than two or three hundred yards. The most abundant of these intercalated sediments are arenaceous types which show all gradations from well-washed quartzites to arkosic grits and greywackes. Some of these arenaceous beds display cross bedding structures, while the more typical greywacke types show graded bedding or merely alternations of coarser and finer material. The shales are always grey in colour and vary from normal argillites to calcareous and arenaceous types. Many are banded and finely laminated.

Sporadic boulders and pebbles indicative of the presence of floating ice are common. One isolated bed of buff-coloured impure limestone about one foot wide was traced in the field for 150 yards. Below the "basal quartzite" horizon the lens-like character is very pronounced. The thin-bedded glacigene sediments often finger out into masses of structureless tillite which must have been heaps of glacial moraine on the depositional surface. The occurrence of this massive tillite in the noses of many of the minor fold structures seems more than coincidental and possibly these masses of coarse detritus have exerted some structural control.

(b) Metamorphism of Torrowangee Sediments

Within the area studied the regional metamorphism of the Torrowangee rocks has not been great, and does not exceed the muscovite-chlorite subfacies.

Dynamic metamorphism along the unconformity has in places produced a cataclastic schist from the tillite, in which elongate boulders may be seen. This grades into the older Willyama schists through a zone of metamorphic convergence which may be up to three yards in width but is usually quite narrow. At the unconformity near its north-eastern extremity there is a gradation from sheared tillite, through tillite schist, to schist which cannot be differentiated from the Willyama schist.

Apart from the low grade regional and dynamic metamorphism which has probably accompanied the folding, the Torrowangee sediments are unaltered. No evidence of post-Torrowangee igneous activity has been found, but quartz veins up to a foot or so wide and several hundred feet long commonly follow the axial plane direction. Occasional quartz blows of larger dimensions are seen.

STRUCTURE

(a) The Willyama Rocks

To the south of Brewery Well the Willyama rocks are metasediments in which the original sedimentary bedding is still well preserved. These beds occupy a position on the eastern limb of a south-pitching syncline, with dips generally very steep and in places vertical or overturned. Plunge indicated by drag folds, is about 50° to the south. Puckering of the less competent beds occurs in the noses of folds with simultaneous shattering of interbedded siliceous rocks.

To the east of these low grade metasediments the dynamic metamorphism gradually increases and the older rocks in the eastern portion of the area appear to have been the locus of intense shearing movements. The foliation of the coarser-grained schists occurring here trends north-south and is usually vertical but in places it dips steeply to the east. A strong lineation in the plane of foliation pitches south at 50° corresponding to the pitch of the structures in the low grade metasediments further west. In the area of cataclastic schists the original bedding structures have been almost obliterated. Occasionally bands of more competent siliceous rock can be seen cutting across the foliation, but they cannot be followed for any great distance in the field. An attempt has been made to plot these structures from serial photographs and the trend lines thus obtained indicate much tighter folding than in the western portion of the area. From the scanty field evidence it appears that these structures also plunge steeply to the south. Thin siliceous bands are often sheared out, giving boudinage structures. These at times have the appearance of quartzite boulders in a schistose matrix and could be mistaken for ancient boulder beds.

(b) The Torrowangee Rocks

Within the area studied the Torrowangee rocks show greater apparent complexity of folding than is seen in the older rocks which they overlie. They occupy a position on the western limb of the Yancowinna syncline which in general is a broad open field plunging to the north at a shallow angle. (King and Thomson,

1953.) The axis of this major syncline occurs some four miles to the east of the Paps (*vide* fig. 1). The Willyama core of the corresponding anticline to the west is seen as a triangular-shaped area of older rocks, with its apex directed to the north. This anticlinal axis lies to the west of the Brewery Creek pluton.

The axial direction of the minor folds is north-south. The north plunge varies considerably, in places being almost 60°. Axial plane cleavage, usually vertical but sometimes dipping steeply to the east, is well developed in the less competent members of the series, and in places, particularly in the lower beds, there appear to have been some shearing movements following this weakness. Faulting of the Torrowangee beds is not common, although a major fault bounds the northern side of the Brewery Creek pluton. Here a small tongue of granite-tillite which rests unconformably on the granite has been raised into contact with normal tillites higher up in the series (*vide* geological map). In general the beds of the Torrowangee series appear to be infolded into the older rock, suggesting that compression of the basement has been the main cause of folding in the cover strata. This basement folding hypothesis which has recently been outlined by Lees (1952) is supported by several facts:

1. The dip of 60° of the unconformity off the Brewery Creek granite could be explained by folding of the granite itself.
2. The trend of folding in both the cover rocks and the basement rocks is north-south.
3. Folding of the basement in the eastern part of the area is more complex than in the cover strata.
4. To the south of the Brewery Creek pluton, where the folding of Willyama appears to be more simple than that in the Torrowangee Series, there does appear to be some swing of the older beds in harmony with the younger beds, at the unconformity.

However, the relatively simple fold structures which exist in the basement over a large part of the area, the big difference in plunge between the older and the younger rocks, and the fact that Torrowangee fold pattern is not clearly reflected on the older rocks, all suggest that other factors have contributed to the complexity of the unconformity.

1. The overlying sediments may have folded independently of the basement rocks.
2. Steep depositional dips are likely to have occurred in the glacigene sediments, particularly in the case of the coarser boulder beds, although no evidence of this could be found.
3. The topography of the pre-existing land surface, especially in the vicinity of the dynamically metamorphosed schists, is likely to have been highly irregular and would explain the presence of many small inliers and outliers.
4. A small amount of folding of the basement rocks may produce considerable crumpling of the overlying sediments if these are confined between the relatively steep sides of a glacial valley.
5. Faulting in the basement rocks may be reflected as folds in the cover strata. Upthrusting of the basement from the south along pre-existing south--plunging linear weaknesses in the Willyama schist could explain the abnormal plunge in the basal beds of the Torrowangee Series. An overthrust from the east has been mapped in the central portion of the area.
6. Different fold patterns may have developed in the Willyama and Torrowangee rocks because of the difference in plasticity between these two distinct lithological groups.

THE AGE OF THE GRANITE

For many years the granite was considered to be Middle Precambrian; however, recently a post-Torrowangee age has been postulated mainly on structural evidence (King and Thomson 1953). From a study of the Brewery Creek pluton and the adjacent Torrowangee sediments a pre-Torrowangee age is indisputable.

On the eastern side of this pluton, contact metamorphic effects on the Torrowangee sediments are entirely lacking while Willyama rocks, occurring as roof pendants and along the contact of the southern margin of the granite, have been slightly metamorphosed. This, coupled with the abundance of granite boulders in the basal beds of the tillite which overlies the granite, indicates that the granite was introduced before tillite deposition commenced. This is confirmed by outcrops in the Brewery Creek gorge in the vicinity of the Paragon mine, which is situated about a half mile beyond the north-western limit of the area mapped. Here the basal beds of the Torrowangee Series can be seen resting unconformably upon the eroded basement of granite. Near the unconformity the bedded tillite consists almost entirely of granite boulders in an arkosic matrix (*vide* p. 128), but this grades into normal tillite higher up in the series. At the contact between the Willyama sediments and the granite in this locality, the granite has been intruded along bedding planes, giving a distinctive type of veined rock. Boulders identical with this composite rock can be found in the adjacent tillite (pl. X, fig. 1 and 2).

Although evidence points to a pre-Torrowangee age for the granite, certain exposures along the unconformity both north and south of Brewery Well and particularly in the vicinity of the stockyards, seem to contradict this. These are discontinuous outcrops of granite which occur along the unconformity itself and in two isolated cases in the tillite a foot or so above the unconformity plane.

First impressions suggest that these are dykes or sills which have been intruded at a later date than the tillite deposition. However, all the dykes and smaller masses of granite occurring in the area and the marginal facies of the Brewery Creek mass are fine in grain size, yet these occurrences now being considered are coarse-grained and very similar to the coarser granite occurring in the central part of the Brewery Creek pluton.

After studying these outcrops in the field it is now thought that they represent large boulders and blocks of granite which rested upon the original erosion surface at the time tillite deposition commenced.

It is concluded that all the granite in the area studied is pre-Torrowangee in age.

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Fig. 1
"Chiastolite" phyllite. 9668. x 8.

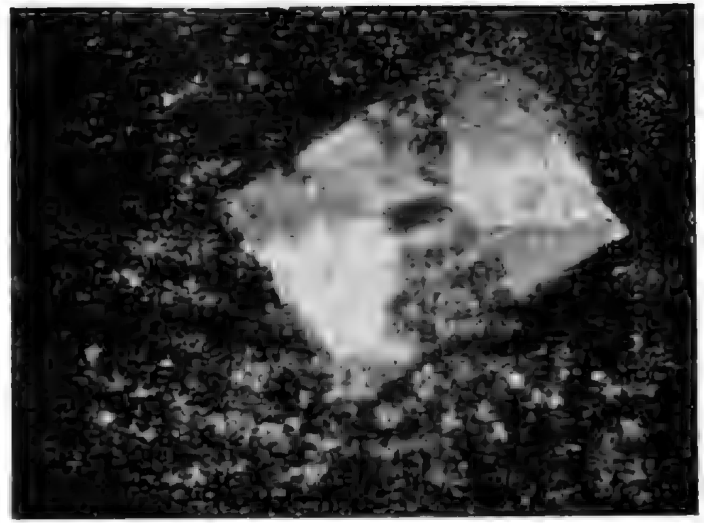

Fig. 2
Enlargement of cross section in top left-hand corner of above showing replacement of chiastolite by quartz and sericite. Crossed Nicols x 56.

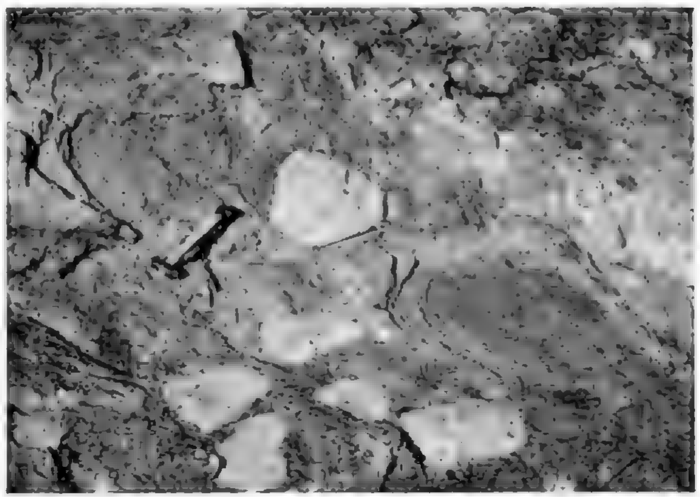

Fig. 3
Exposure of granite tillite in bed of Brewery Creek.

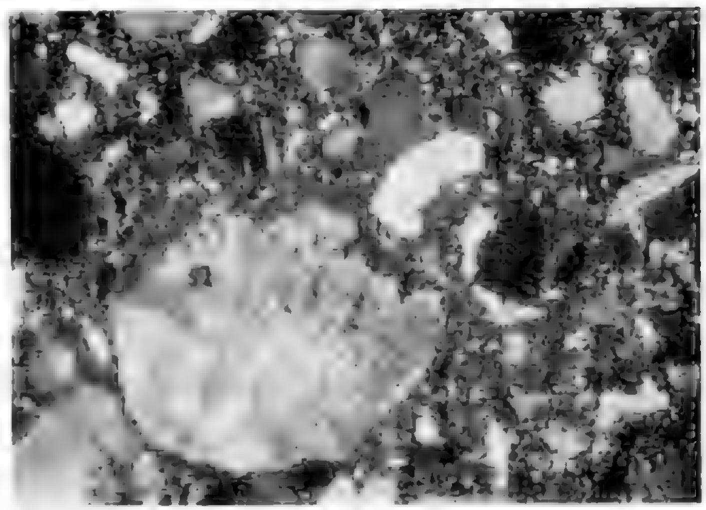

Fig. 4
Thin section of granite tillite matrix. 9682. Crossed Nicols x 20.

Fig. 1
Granite intruded along bedding of Willyama metasediments—
Brewery Creek.

Fig. 2
A boulder of rock identical with that shown above in overlying tillite—
Brewery Creek.

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LOWER CRETACEOUS PLANT REMAINS FROM THE VICINITY OF MOUNT BABBAGE, SOUTH AUSTRALIA

BY *M. F. GLAESSNER** *AND* *V. R. RAO†*

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[Read 14 October 1954]

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A number of Lower Cretaceous plant remains from the north-eastern Flinders Ranges, from strata previously considered as Tertiary, are described. The only previously described species is placed in a new genus *Nathorstianella*.

INTRODUCTION

The material on which this account is based was collected by one of the authors (V. R. R.), jointly with Mr. G. D. Woodard and Mrs. E. B. Summers, during September 1953. One specimen collected at Mount Babbage (1,011 ft., lat. 29° 54′ south, long. 139° 40′ east) by Dr. D. R. Bowes in 1950, and another collected by Miss M. J. Wade in 1950 have also been included. All specimens are in the palaeontological collections of the University of Adelaide. The stratigraphy of the area is the subject of a recent paper by G. D. Woodard (1955), to which the reader is referred for a detailed description of the localities, their stratigraphic relations, and the age determination of the strata. A photograph of Mount Babbage was recently published by Bowes (1953, pl. 10, fig. 1). Previous work on the area includes a description of plant remains by H. Woodward (1885) who determined correctly the age of the flora as Mesozoic, although insufficient material led him to erroneous identifications. Unfortunately, his paper was not known to Woolnough and David (1925) who placed the plant-bearing strata at the top of Mount Babbage in the Tertiary, using for these and other non-marine deposits of the Lake Eyre Basin the term "Eyrian Series." This term has since found wide application in stratigraphic literature and in map legends, though it is still ill-defined. At the same time Woolnough and David considered the plant-bearing boulder beds at the foot of Mount Babbage and in the vicinity of Muloowurtina Homestead as evidence of Cretaceous glaciation. Woodard has now shown that they are gravel and boulder beds at the base of the Lower Cretaceous transgression. Mr. S. B. Dickinson, Director of Mines, has informed us that he collected a few years ago plant remains in the same area which were determined as of Mesozoic age. The results of these investigations are unpublished.

SYSTEMATIC DESCRIPTIONS

Nathorstianella nov. gen.

Nathorstianella babbagensis (H. Woodward)

Pl. XI, fig. 1-4

1885 *Mantellia babbagensis*, H. Woodward, Geol. Mag., n.s., (3), 2, p. 290, pl. 7, fig. 1, 2.

Material—Six stem fragments of varying lengths (30-180 mm.); a stem fragment with root-bearing base but without rootlets; one conical fragment, possibly of a young stem base.

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Preservation—Casts in quartzite, without organic substance. The quartzite is the alteration product of sandstones which is widespread on old erosion surfaces in Central Australia and which is part of the "duricrust" described by Woolnough.

Locality—Top of Mount Babbage (1,011 ft.) Northern Flinders Ranges, South Australia.

Holotype—A.U.G.D. No. F. 15070 (pl. XI, fig. 1a, b).

Description—The root-bearing base measuring about 55 mm. in diameter and 18 mm. high, is divided into lobes by four radial grooves arranged in two opposing pairs which are joined by a short straight groove. The angles at its ends are less than 90°, those formed on either side of it by the radial grooves are more than 90°. This arrangement corresponds to that seen in the stem base of *Pleuromeia* in which the surface layers are not preserved (Mägdefrau 1931, fig. 2). In this genus, according to Mägdefrau, a crevice extends downward almost to the external surface of the stem base. This explains the appearance of the grooves on the surface of the present specimen. The central groove also corresponds to the "split" in the "stock" of the living *Isoetes*. As in *Pleuromeia*, the surface of the stem base is covered with rootlet scars. They measure about 2 mm. in diameter and are mostly preserved as ring-shaped depressions. In the best-preserved scars the depression is horseshoe-shaped, enclosing a slightly eccentric elevation, as in *Pleuromeia* and *Nathorstiana*. No appendages have been found. The scars are closely spaced, without any visible regularity in their arrangement. The outline of the base is angular, with the grooves ending at the angles which do not project. The lower surface of the stem base is convex between the grooves but one of these areas has been flattened, apparently in the course of embedding or fossilization, and partly broken radially. Its margin now projects outward, giving the base a roughly pentagonal outline. The peripheral margin of the base is rounded in lateral view. Above it, the stem base slopes inward for a short distance and then grades into the stem.

A conical fragment (pl. XI, fig. 4), about 38 mm. in diameter and 20 mm. high, may represent a young growth stage of the stem base. Its surface shows a projecting ring 27 mm. in diameter but no rootlet scars.

The stem is conical, sloping (in a large fragment without base, pl. XI, fig. 2) from a diameter of 71 mm. to 40 mm. over a length of 180 mm. This is the largest fragment found to date. It shows expanded rings about 10-20 mm. distant, while more closely spaced rings and also wider bulbous expansions are seen in other fragments. The surface of the stem is densely covered with minute leaf scars, which are 1-3 mm. long, very low and transversely elongate (slit-like). No details of the structure of these scars are preserved in the coarse matrix. Their arrangement is spiral and the spacing is such that the impression of both low-angled and high-angled spirals is created. Neither leaves nor cones have been found.

Comparison—A stem fragment closely resembling the largest specimen in the present collection was described from the same locality by H. Woodward (1885), as follows:

"On the exterior a thin carbonaceous crust, most of which is now removed, renders more prominent a fine network of extremely minute compressed elliptical or lozenge-shaped scars, indicating the bases of the petioles; 6 of these scars measure only 20 mm. in breadth, and 9 scars occupy the same space in height. The diameter of the stem is 5 centimetres.

The fragment is, I have no doubt, a portion of the stem of a plant which has been closely covered with leaves, such as we find in some Monocotyledonous plants like "Blackboys" and "Grass trees" (*Xanthorrhaea* and *Kingia*) of Aus-

tralia, or perhaps still more like those Cycadeae whose stems are covered with the permanent bases of the leaves. I have compared this specimen with the figures of *Mantellia inclusa,* Carr., given by Mr. Carruthers in his memoir on "Fossil Cycadean Stems from the Secondary Rocks of Britain (Trans. Linn. Soc. Lon., 26, 1868, 703, tab. lxiii, fig. 2, 3). . ."

"Of course but little can be said in the way of detailed description of so fragmentary a fossil remain; nevertheless, from the comparison I have made, I am inclined to consider this fossil to belong to the *Cycadeae* and perhaps to the genus *Mantellia.* If it be desirable, for convenience of reference, to give it a specific name, I would suggest *M. Babbagensis* as its trivial name, after the locality from whence it was derived."

It is noted that the genus *Mantellia* Brongniart 1828 was considered by Seward (1917, p. 365) a synonym of *Cycadeoidea* Buckland 1827.

Although Woodward correctly described the appearance of the stem of this plant, he was misled by its superficial resemblance to a cycad trunk. The discovery of the root-bearing base has made it clear that its relations are with *Nathorstiana* (Richter 1909, Mägdefrau 1932, 1953) and *Pleuromeia,* and therefore with the Lepidophytales and the living Family Isoetaceae. This Family is linked morphologically and phylogenetically, as many authors and more recently particularly Richter and Mägdefrau have pointed out, through these two Mesozoic genera with the Palaeozoic Lepidodendrons and Sigillarias. The root-bearing stem base of *Pleuromeia* and *Nathorstiana* is essentially a reduced Stigmaria. In the Australian form it differs from that of *Pleuromeia* in the almost complete absence of the expanded and upturned lobe-like expansions at the ends of the grooves. These "horns" are here represented only by the four corners of the base, so that the slightly inflated areas between them begin to resemble the lobes of the "stock" of *Isoetes.* The stem base of the fossil plant from Mount Babbage differs from *Nathorstiana* in the relatively much reduced length (height) and in the distinctly four-lobed basal surface. Equally important differences from both genera are found in the leaf-bearing stem. It is much shorter than in *Pleuromeia* but longer than in *Nathorstiana;* the leaf scars are much smaller and more closely spaced than in *Pleuromeia* but apparently more distinct than in *Nathorstiana.* The Australian species is therefore in all observable characters distinct from and intermediate between *Pleuromeia* and *Nathorstiana,* and has to be placed in a new genus.

Genus **Nathorstianella** nov.

Type species *N. babbagensis* (H. Woodward)

Description—A genus of the Isoetaceae with a short root-bearing stem base which is closely and irregularly covered with rootlet scars and divided into four lobes by deep grooves; its outline does not project at the outer ends of these grooves. The leaf-bearing stem is long and tapering, with annular expansions, and bears numerous very small transversely elongate and closely spaced leaf scars.

Relations—It is possible, although it cannot be proved, that *Isoetites elegans* Walkom, from fine-grained clayey sandstones underlying the Cretaceous greensands at Gingin, Western Australia, belongs to this genus. This species was based by Walkom on a group of leaves and sporangia. The arrangement of leaves in the type specimen (Walkom, 1944, pl. 1, fig. 1) suggests that they were attached to a stem about 40 mm. in diameter; their bases were 3-4 mm. wide. These measurements agree with those of the stem and the leaf scars in *Nathorstianella.* Further discoveries, either of stems in Western Australia or of leaves on Mount Babbage, must be awaited before this suggested relation can be tested. It would be of great interest as the sporangia in *Nathorstiana* and *Nathorstianella* are not known. The validity of the new generic name would not be affected by it as the

genus *Isoetites* Münster 1842 was based on an "imperfectly preserved and indeterminable fossil" (Seward, 1910, p. 67) and none of the other species placed in this genus resembles the Western Australian species; two of them are described by Walkom as "very different," while *Isoetites choffati* (Saporta) was based on "small relatively broad tuberous bodies reaching a breadth of 1 cm." (Seward, 1910, p. 67) and basal portions of sporophylls. There is no reference to a stem.

The discovery of this new genus confirms the view that a line of evolution leads from the Lower Triassic *Pleuromeia* which is known from Europe, East Asia and Australia, through *Nathorstiana* (known only from the Lower Cretaceous of Germany), to *Isoetes*. It helps to bridge the gap between the two extinct genera. *Nathorstianella* shows a reduction of the lobes of *Pleuromeia*, but this does not go as far as in *Nathorstiana;* on the other hand, the new genus does not show the lengthening of the root-bearing base associated with a shortening of the leaf-bearing stem which is clearly shown in the German Cretaceous form (see Mägdefrau 1932, fig. 2, and 1953, fig. 240), and which becomes excessive in *Isoetes* where the "stem" has disappeared in the "stock" (Lang 1915).

Age—The age of *Nathorstianella* does not differ significantly from that of *Nathorstiana* which is Barremian. The Blythesdale sandstone containing these fossils in its upper part which forms the top of Mount Babbage, is directly overlain 4 miles eastward by the fossiliferous marine Roma Formation of Aptian age (Woodard 1955).

Ecology—Mägdefrau (1953) has made it probable that *Nathorstiana* lived in coastal sand dunes. *Nathorstianella* was found in some abundance in coarse sandy deposits, and although these fossils have not been observed in positions of growth it seems likely that they are either *in situ* or at least that they have not been transported far. The sand in which they are embedded is derived from locally outcropping Precambrian quartzites and appears to have been deposited by streams or in lakes. Their sandy banks provided the habitat of *Nathorstianella.*

CLADOPHLEBIS Brongniart 1848

CLADOPHLEBIS AUSTRALIS (Morris)

Pl. XII, fig. 12, 13

1917 *Cladophlebis australis* (Morris), Walkom, Qld. Geol. Surv. Publ., 257, p. 3, pl. 5, fig. 1, 2.

1919 *Cladophlebis australis* (Morris), Arber, Palaeont. Bull. Geol. Surv. N.Z., 6, p. 29, pl. 4, fig. 1, 5, 8.

Frond bipinnate, pinnae obliquely disposed on a slender rachis, attached to the rachis by the whole base, oblong, apex rounded, midrib well defined, extending to the apex, secondary veins make an acute angle with the midrib, margin entire, pinnae wide apart, four pinnae seen in the specimen.

Measurements of the pinna—Length = 5 mm. Width = 2·5 to 3 mm.

Locality—The figured specimen was collected from an outcrop about 2 miles north-east of Flinders No. 5 talc mine, situated about 10 miles west of Mount Babbage (see Bowes 1953, fig. 2). In another specimen from the Woolshed section the pinnae are longer and closer to each other.

TAENIOPTERIS Brongniart 1828

TAENIOPTERIS SPATULATA McClelland

Pl. XII, fig. 1-7

1908 "*Taeniopteris spatulata* and its varieties." Chapman, Rec. Geol. Surv. Vict., 2, pt. 4, p. 215, pls. 36, 37.

1917 *Taeniopteris daintreei* McCoy, Arber, Palaeont. Bull. 6 Geol. Surv., N.Z., p. 46, pl. 6, fig. 5.

1917 *Taeniopteris spatulata* McClelland, Walkom, Qld. Geol. Surv. Publ. 257, p. 30, pl. 5, fig. 2b.

1919 *Taeniopteris spatulata* McClelland, Walkom, Qld. Geol. Surv. Publ. 263, p. 36, pl. 1, fig. 9.

Frond linear, spatulate in shape, margins roughly parallel, midrib prominent, veins almost at right angles to the midrib, simple, extending from the midrib to the lateral margins, closely packed, about 12 to 16 in 5 mm., apex bluntly pointed or rounded, width of the lamina decreases gradually towards the petiole.

Great variation is observed in the length and width of the frond and the width of the midrib in the 12 specimens studied. The veins are clearly visible on the impressions in sandstone, while they are obscure or absent on the impressions in quartzite.

Measurements—Length = 40 to 100 mm., width in the middle of the lamina = 3 to 10 mm., width of the midrib = 0·5 to 2 mm.

Locality—All the impressions in quartzite are collected from the flat-topped hill about ½ mile north-east of Mount Babbage and those in sandstones from the Woolshed section, Muloowurtina.

OTOZAMITES Braun 1842

OTOZAMITES BENGALENSIS (Oldham and Morris)

Pl. XII, fig. 14

1863 *Palaeozamia bengalensis*, Oldham and Morris, Palaeont. Indica. Ser. 2, 1, pt. 1, p. 27, pl. 19, fig. 1, 2, 6.

1917 *Otozamites bengalensis* (Oldham and Morris), Seward, Fossil Plants, 3, p. 543, fig. 607.

Frond narrow and long, pinnae short, rhomboidal, slightly rounded and produced at their basal upper margin towards the narrower end, rectangular with parallel edges and rounded apices towards the broader end, arranged alternately on the rachis, closely spaced, attached to the rachis by the whole base in a slightly oblique direction, venation obscure, rachis deep and broad.

Measurements—Length of the frond = 50 mm. Width of the frond: narrower end = 4 mm., broader end = 6 mm. Pinna, narrower end: length = 2 mm., width = 2 mm.; broader end: length 3 =m., width = 1·5 mm.

Locality—Only one specimen was collected from flat topped hill north-east of Mount Babbage.

CYCADITES Sternberg 1833

CYCADITES sp.

Pl. XII, fig. 9

cf. 1917 *Cycadites* sp., Arber, Palaeont. Bull. Geol. Surv., N.Z., 6, p. 51, fig. 10.

Specimen not well preserved, frond bipinnate, pinnae narrow and linear, gradually tapering towards the apex, attached to the rachis by the whole base, midrib paired, rachis broad and deep with roughly circular depressions, pinnae preserved only on one side of the rachis.

Measurements of the largest pinna—Length = 25 mm.: width (near the base) = 5 mm.; (near the apex) = 2 mm. Width of the rachis = 3 mm.

Locality—Woolshed section, Muloowurtina.

Nilssonia Brongniart 1824
Nilssonia schaumburgensis (Dunker)
Pl. XII, fig. 8

1895 *Nilssonia schaumburgensis* (Dunker), Seward, Wealden Flora, II, p. 53, fig. 3.

1917 *Nilssonia schaumburgensis* (?) (Dunker), Walkom, Qld. Geol. Surv. Publ. 263, p. 33, pl. 1, fig. 14, 15.

Frond moderately long and broad, segmented, truncated segments of unequal length and width, margin irregular with incisions of varying length in the middle of the frond but wavy and gradually becoming entire towards the petiole and the apex. Veins simple, parallel, 12 to 14 in 5 mm., roughly at right angles to the midrib, extending from the midrib to the lateral margins without bifurcation. The margin of the segments in the middle of the lamina is slightly notched. Apex bluntly pointed. Midrib broad, showing fine ribs running from the petiole to the apex.

This specimen closely resembles *Nilssonia elegans* Arber (Arber 1917, p. 52, pl. 8, fig. 8). Edwards (1934, p. 98) points out that there is practically no difference between the Wealden *N. schaumburgensis* (Dunker) and *N. elegans* Arber of New Zealand and remarks: ". . . but with only a few incomplete specimens for comparison it is safer to allow *N. elegans* to stand for the present."

Measurement of the frond—Length = 60 mm. Maximum width (middle of the frond) = 10 mm. Maximum width of the midrib = 1·5 mm.

Locality—Woolshed section, Muloowurtina (collected by Miss M. J. Wade).

Elatocladus Halle 1913
Elatocladus planus (Feistmantel)
Pl. XII, fig. 10, 11

1919 *Elatocladus planus* (Feistmantel), Walkom, Qld. Geol. Surv., Publ. 263, p. 43, pl. 2, fig. 4, 5.

1934 *Elatocladus plana* (Feistmantel), Edwards, Ann. Mag. Nat. Hist., Ser. 10, 13, p. 103, pl. 5, fig. 3.

Shoot with slender rachis showing two ranked spirally attached leaves, leaves linear, almost of uniform width, apex bluntly pointed, attached to the rachis by the whole base. The specimens are found in quartzite and no further details of the leaves are visible.

Measurements of the leaves—Length = 15-30 mm.; width = 1-2 mm.

Locality—Flat-topped hill, north-east of Mount Babbage.

Coniferous wood

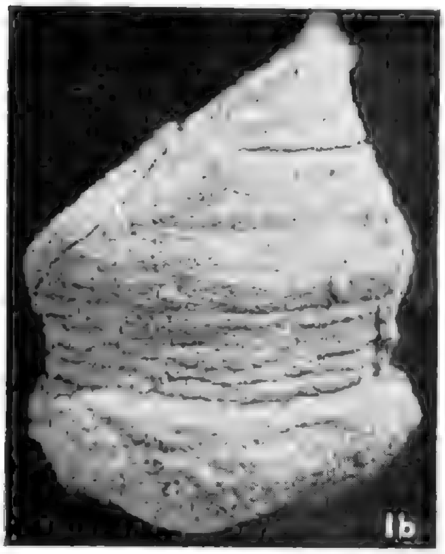
Many well-preserved fossilized tree trunks are found in the Blythesdale Sandstone about 2½ miles south of Muloowurtina Homestead. The tree trunks vary in length from 7 to 36 feet, and in diameter from 1 to 4 feet. Some of the specimens collected show well-marked growth rings. A preliminary examination of the thin sections indicates that the wood is of coniferous nature.

Impressions of woody structures are also seen in the quartzites of Mount Babbage and the flat-topped hills north-east of it.

Affinities of the Flora

With the exception of *Nathorstianella* all the other forms described here are commonly found in the late Mesozoic floras of many parts of the world. Even though it is difficult to determine the affinities of this flora on so few forms, it can be said that it has a close relationship with the Cretaceous floras of Queensland, particularly with the flora of the Burrum series (Walkom 1919a,

1a



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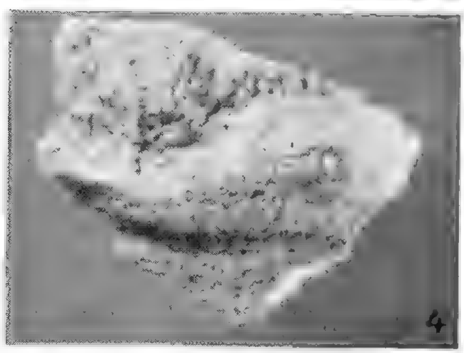

Nathorstianella babbagensis (H. Woodward)

Fig. 1 a, b—Root-bearing base; a, basal view, natural size; 1 b, lateral view, x 0·9. Holotype F. 15075. Fig. 2, 3—Stem fragments, x 0·75, F. 15076, F 15077. Fig. 4—Conical fragment, possibly stem base, x 1·4. F. 15078.

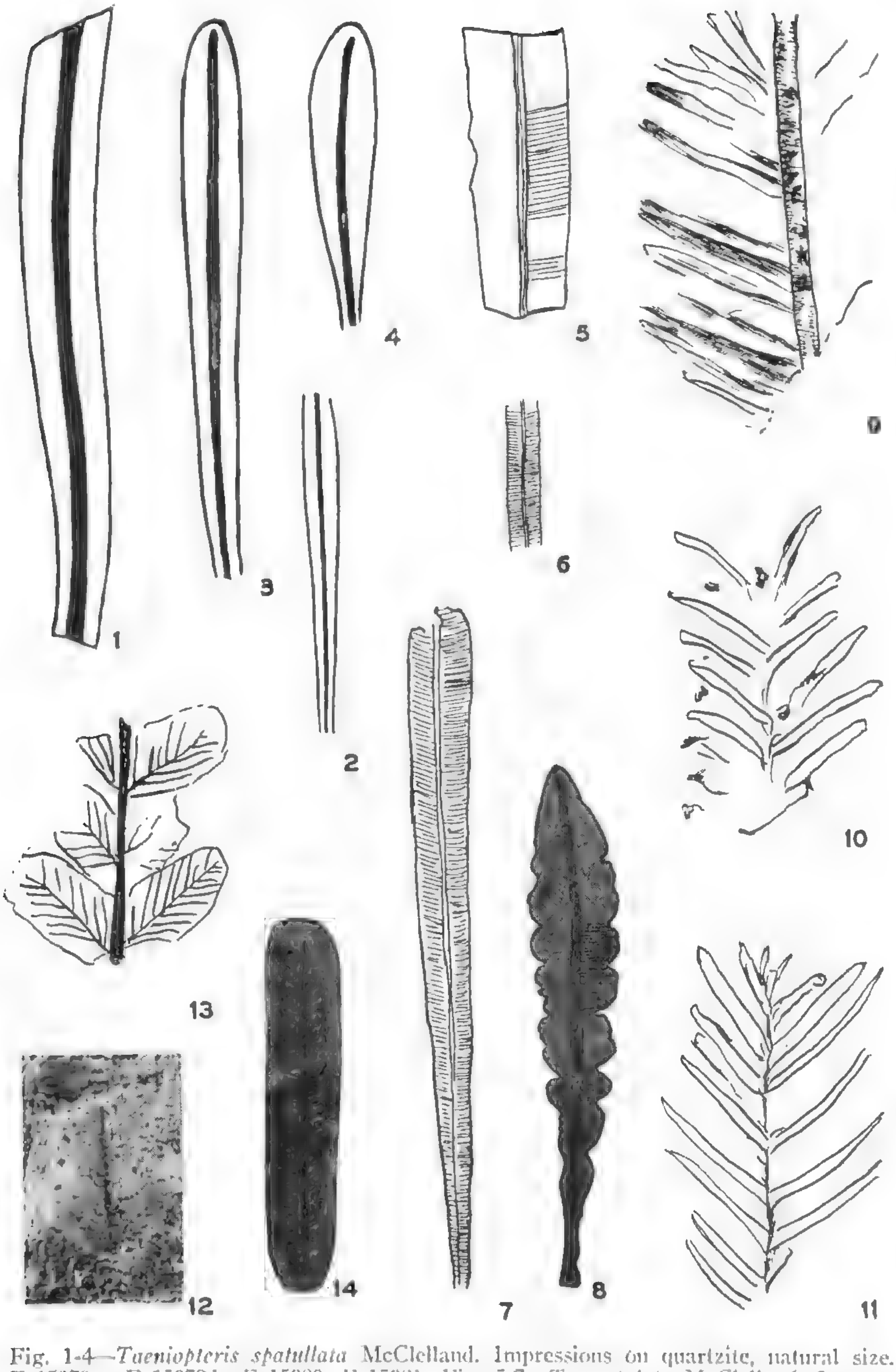

Fig. 1-4—*Taeniopteris spatullata* McClelland. Impressions on quartzite, natural size. F. 15079 a, F. 15079 b, F. 15080, F. 15081. Fig. 5-7—*T. spatulata* McClelland. Impressions on sandstones showing veins, fig. 5, x 2·5, fig. 6 and 7, natural size. F. 15082 to F. 15084. Fig. 8—*Nilssonia* cf. *schaumburgensis* (Dunker) x 1·2. F. 15085. Fig. 9—*Cycadites* sp. natural size. F. 15086. Fig. 10, 11—*Elatocladus planus* (Feistmantel) natural size. F. 15087, F. 15088. Fig. 12, 13—*Cladophlebis australis* (Morris). Fig. 12, x 2, Fig. 13, same, x 4. F. 15089. Fig. 14—*Otozamites bengalensis* (Oldham and Morris), natural size. F. 15090.

1919b). Some of these forms are also described from the Jurassic and Cretaceous of New Zealand (Arber 1917 and Edwards 1934).

The field evidence (Woodard 1955) supports the Lower Cretaceous age of this flora.

ACKNOWLEDGMENTS

The authors are indebted to Professor T. G. B. Osborn for an instructive discussion of the morphology of the living *Isoetes* and for helpful comment and criticism. The field investigations were assisted by a grant from the General Research Funds of the University of Adelaide. The junior author carried out his work during his tenure of a Commonwealth Technical Assistance (Colombo Plan) Fellowship at the University of Adelaide.

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ACANTHOCEPHALA COLLECTED BY THE AUSTRALIAN NATIONAL ANTARCTIC RESEARCH EXPEDITION ON HEARD ISLAND AND MACQUARIE ISLAND DURING 1948-50

BY S. J. EDMONDS*

Summary

Three Acanthocephala are recorded from the sub-Antarctic Islands: *Aspersentis austrinus* van Cleave, *Corynosoma bullosum* (von Linstow) and *Corynosoma clavatum* Gosse. *Corynosoma* sp. is also recorded from a penguin.

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[Read 14 October 1954]

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Three Acanthocephala are recorded from the sub-Antarctic Islands: *Aspersentis austrinus* van Cleave, *Corynosoma bullosum* (von Linstow) and *Corynosoma clavatum* Gosse. *Corynosoma* sp. is also recorded from a penguin.

INTRODUCTION

Most of the Acanthocephala described in this report were collected by R. G. Chittleborough and E. H. M. Ealey while stationed with the A.N.A.R.E. at Heard Island during 1949. Two species were collected by N. M. Haysom at Macquarie Island in the same year.

LIST OF PARASITES EXAMINED ARRANGED ACCORDING TO THEIR HOSTS

Fish

Nototheniа coriiceps Richardson—*Aspersentis austrinus* van Cleave, 1929, and structure in both sexes is 0·25 mm. and occurs toward its posterior extremity. larval form of *Corynosoma bullosum* (von Linstow, 1892), Heard Island.

Notothenia cyanobrancha Richardson — *Aspersentis austrinus* van Cleave, 1929, Heard Island.

Birds

Phalacrocorax atriceps nivalis Falla *Corynosoma clavatum* Gosse, 1940, Heard Island.

Pygoscelis papua Forster—*Corynosoma* sp., Macquarie Island.

Mammals

Mirounga leonina Linn.—*Corynosoma bullosum* (von Linstow, 1892), Heard and Macquarie Islands.

Hydrurga leptonyx (de Blainville)—*Corynosoma bullosum* (von Linstow, 1892), Heard Island.

DESCRIPTION OF PARASITES

Aspersentis austrinus van Cleave, 1929

Fig. 1

Heard Island—Catalogue number of collections 233, 426, 428, 428, 488, 489.

About 30 specimens of this parasite, most of which are females, were found in the intestine of the fish, *Notothenia coriiceps* and *N. cyanobrancha*.

The length of the body or trunk of the males excluding the proboscis is 4·4-5·1 mm., and of the females 6·4-9·2 mm. The maximum width of the males is 1·2 mm., and of the females 2·2 mm. Two females which had contracted very much in length and whose shape seemed abnormally rounded were 3·3 mm. wide. The length of the proboscis, which when when fully extended is curved ventrally to a slight extent, lies between 0·75 and 0·85 mm. The minimum width of the There is an unarmed neck up to 0·3 mm. long. The proboscis is armed with 14 rows of 9-11 hooks per row and the hooks on its ventral surface are largest.

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The maximum length of the proboscis sheath is 1·3 mm. The body wall is thick and the anterial ventral surface of the worm is armed with body spines. The lemnisci are a little longer than the proboscis sheath.

The testes are oval in shape and of approximately equal size; their maximum length is 0·75-0·90 mm. and width 0·44-0·60 mm. Six cement glands are present and their ducts remain separate almost to the base of Saefftigen's pouch.

The uterus is as much as 2·6 mm. long, and in some cases much distended with eggs; its maximum width is 0·32 mm. Ripe eggs are 78-85μ long an 18-25μ wide and possess polar prolongations.

Four smaller specimens of *A. austrinus* were obtained from the intestine of *Notothenia cyanobrancha*. The four worms consisted of two males and two females. In two specimens the proboscis was extended sufficiently to make identification possible.

Aspersentis austrinus was described by van Cleave (1929) from "*Trematomus or Notothenia*" from South Georgia. *Rhadinorhynchus wheeleri* Baylis 1929 from *Notothenia rossii* seems to be synonymous with *A. austrinus*.

Corynosoma clavatum Gosse, 1940

Fig. 2

Heard Island—Catalogue number of collection 201.

Two male and five female specimens of this parasite were found in the intestine of the shag, *Phalacrocorax atriceps*. The worms are small and their shape resembles that of a pipe with a large bowl. In none of the specimens was the probsocis fully everted, and in all cases it had sunk below the rim of the bowl. The length of the parasites measured from the most anterior point of the bowl in a straight line to the genital aperture is in the case of the males 2·1-2·3 mm. and of the females 2·3-2·7 mm. The maximum width or diameter of the circular bowl or disc of the males is 1·5 mm. and the females 1·6 mm. The introvert, consisting of an armed and small unarmed portion, would be about 0·8 mm. long when fully extended; its maximum width about 0·3 mm. The proboscis is armed with 16 longitudinal rows of hooks. The exact number of hooks in each row has not been determined with certainty. It is estimated that there would be 10-11. The posterior four hooks of each row are smallest and the fifth or sixth hook of each row is the largest. The size and shape of the largest hook is shown in fig. 2. The proboscis sheath is double walled and its maximum length is 1·0 mm. The anterior region of the parasite, the disc or bowl, bears numerous rows of small spines about 28μ long. The remainder of the body is devoid of spines,, except the genital region which bears a few very small spines. The genital spines are particularly noticeable in the two male specimens. Eggs 73-76μ long and 32-36μ wide were present in two of the females.

C. clavatum has now been reported from a number of shags in the southern hemisphere; by Gosse (1940) from *Phalacrocorax ater*, *P. melanoleuca* and *P. varius*, and by Johnston and Best (1942) from *P. varius*. The larval form has been reported from the fish, *Platycephalus fuscus*, by Johnston and Edmonds (1952).

Corynosoma bullosum (von Linstow, 1892)

Fig. 3-5

Heard Island—Catalogue number of collections 144, 218, 219, 304, 361, 426, 427, 428, 470, 483, 503.

Macquarie Island—MI/49/P7.

Adult Form

A very good collection consisting of over 100 specimens in an excellent state of preservation were obtained from the intestine of the sea elephant,

Mirounga leonina. Two specimens were also found in material collected from the intestine of the sea leopard, *Hydrurga leptonyx.* Most of the specimens were yellow to orange in colour.

The maximum length (excluding the proboscis) of the males is 6·2 mm., and of the females 12·2 mm.; the maximum width (in the anterior region) of the males is 1·6 mm., and of the female 1·9 mm. The proboscis is cylindrical in shape and 0·94-1·10 mm. long. Its maximum width is about 0·26 mm. It is armed with 15-16 longitudinal rows of 11-13 hooks per rom. Except for the posterior 3 or 4 there is little differentiation in their size and shape (fig. 3).

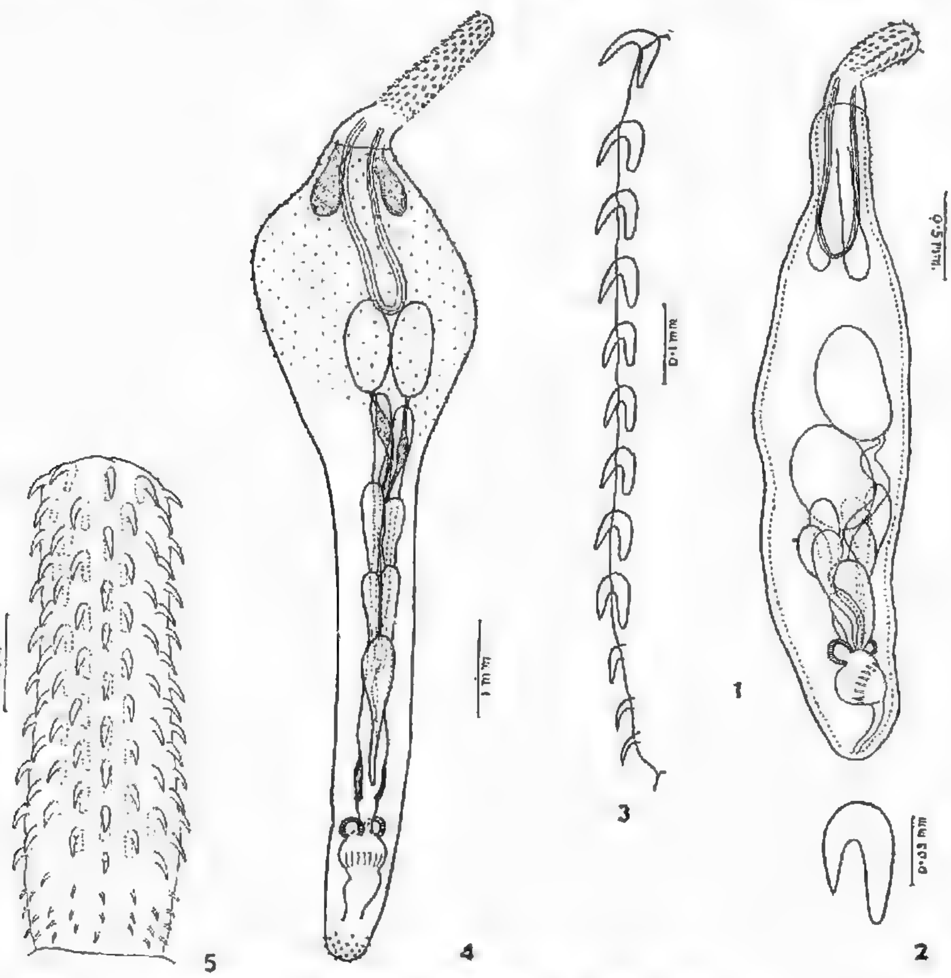

Fig. 1—*Aspersentis austrinus.* Adult male.
Fig. 2—*Corynosoma clavatum.* Largest proboscis hook.
Fig. 3-5—*Corynosoma bullosum.* Fig. 3, proboscis hooks; fig. 4, adult male; fig. 5, proboscis

There is an unarmed neck as long as 0·4 mm. The proboscis sheath is double walled; its maximum length is 1·4 mm., and width 0·30 mm. An elliptical ganglion is present near the middle of the sheath. The anterior swollen portion of the body and the genital region of both sexes bears small spines.

Two oval-shaped testes of approximately equal size lie in most specimens at about the same level; their maximum length is 0·7-0·9 mm., and width 0·32-0·45 mm. There are six long tubular cement glands arranged in pairs. The testes and cement glands are placed in most specimens so as to make the male bilaterally symmetrical. Two vasa deferentia unite about the level of Saefftigen's

pouch. There is a well developed bursa everted in a number of specimens and bearing about 20 rays.

The female system consisting of a bell, uterus and vagina is as much as 3·5 mm. long. The vaginal complex consists of three bulbs. The posterior region of a number of females forms an introvort up to 0·5 mm. long. Ripe eggs with polar prolongations of the middle shell are 93-105μ long and 20-26μ wide.

C. bullosum has been reported previously (Meyer 1932) from *M. leonina*.

LARVAL FORM

Some specimens consisting of 14 cysts, 3 larvae emerging from cysts and 2 freed larvae, collected from the mesentery of *Notothenia coriiceps*, have been identified as *C. bullosum*. The cysts are oval to kidney-shaped and white in colour. Their maximum length is 1·6-2·0 mm., and width 0·7-0·9 mm. The identification is based on an examination of the emerging and freed larvae. The two larvae which had lost their cyst cases are females. The length of their body measured from the base of the proboscis to the genital aperture is 3·5-3·7 mm. The maximum width of the anterior swollen body region is 1·2-1·4 mm. The proboscis, 0·90-0·96 mm. long and about 0·26 mm. wide, bears 16 longitudinal rows of hooks, each row consisting of 13 hooks. The anterior portion of the body and the region surrounding the genital aperture bear small spines.

The larval form of *C. bullosum* has been recorded from the peritoneum of *Chaenocephalus aceratus* by Baylis (1929).

CORYNOSOMA sp.

Macquarie Island. MI/49/P33.

Four immature acanthocephala were obtained from the intestine of the penguin, *Pygoscelis papua*. The proboscis of none of the specimens is fully extended and the reproductive organs are in the early stages of development. The anterior swollen portion of the body and the ventral surface of the parasites bear small spines. The genital aperture is surrounded with very small spines. Identification, however, will have to be withheld until more material is available for examination.

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SOME OBSERVATIONS ON THE BIOLOGY, INCLUDING MATING AND OTHER BEHAVIOUR, OF THE AUSTRALIAN SCORPION URODACUS ABRUPTUS POCOCK

BY R. V. SOUTHCOTT

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Adults of this species of scorpion have been kept in captivity up to 22 months.

A supposedly parturient female of *U. abruptus* was observed, on very hot days in summer, to adopt an elevated stance, with the abdomen hyper-extended on the cephalothorax, with the telson drooping forwards. A similar, but less marked, attitude has also been observed in males of this species, under hot humid conditions. The purpose of this attitude is uncertain, but probably it has a respiratory and perhaps cooling function.

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INTRODUCTION

The genus *Urodacus* Peters 1861 is confined to Australia, some 15 species being recognized. Two species of this genus occur in the vicinity of Adelaide, South Australia. The smaller darker species is the subject of the present paper, and will be referred to *Urodacus abruptus* Pocock 1888.[1] It lives in shallow tunnels in loamy soil, chiefly under stones, and is not uncommon in the Mount Lofty Ranges. The larger species is less common. It is lighter in colour, brown, and excavates tunnels in sand or sandy soils, these tunnels opening free to the surface. It will be referred to *U. armatus* Pocock 1888, described originally from a male specimen from Port Lincoln, South Australia.

RECORDED DISTRIBUTION OF U. ABRUPTUS

Urodacus abruptus Pocock 1888 was described from two females in the collection of the British Museum—"one ticketed Adelaide, the other merely New Holland." In 1893 Pocock referred again to this species, describing the male and stating, "This species seems to be common in South and South-east Australia. The type of the species (a dried specimen) came from Adelaide; but since it was described I have seen others in the Museum of Owens College, Manchester,

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[1] In the present paper I have followed the classification of Pocock (1888, 1893, 1898, 1902) rather than that of Kraepelin (1899, 1908, and earlier papers). The latter author regarded *U. novaehollandiae* Peters 1861 and *U. abruptus* Pocock 1888 as conspecific with *Ioctonus manicatus* Thorell 1876. Although Kraepelin stated that he had come to this opinion after a study of Thorell's original specimens, there are so many gross discrepancies between Thorell's brief description and any *Urodacus* of which I am aware, that I consider it extremely unlikely that Kraepelin had Thorell's original specimens (from "Nova Hollandia") before him. Numerous errors by Kraepelin in both observation and interpretation are pointed out by Pocock (1891, 1898, 1902). Unfortunately it does not appear likely that Thorell's types can be recovered (Vachon 1954, personal communication) .Both species in the Adelaide region correspond to Pocock's descriptions for *U. abruptus* and *U. armatus* respectively. The systematics of the genus *Urodacus* will be considered further in later papers.

which are ticketed Mount Lofty, South Australia, and Victoria." In 1898 Pocock reviewed the genus *Urodacus*. For *U. abruptus* he gave as localities "South and South eastern Australia, Adelaide, type (59.52); Ballarat and Bendigo, in Victoria (W. W. Froggatt); Cooma, Bathurst, Maitland, Yass, in New South Wales (W. W. Froggatt); New England District of New South Wales (J. Macpherson).

"Since I described this species the British Museum has received a very fine series of it from Mr. Froggatt and Mr. Macpherson from the localities mentioned above."

Glauert (1925) stated that this species extends in its geographical distribution from New South Wales through Victoria to South Australia. He states further: "Whether it enters Western Australia is doubtful. Kraepelin states that it occurs there, but I have failed to find it among the hundred or more specimens of *Urodacus* which I have received from all parts of the south of Western Australia. On the other hand, the *Urodacus*, so plentiful in the vicinity of Eucla, is *U. novae-hollandiae;* this suggests that *U. manicatus* (*U. abruptus*) does not reach the western boundary of South Australia." In the same paper Glauert recorded two specimens of this species from Kangaroo Island, South Australia.

PRESENT OBSERVATIONS ON HABITAT AND DISTRIBUTION

Urodacus abruptus is found in loamy soil in eucalypt forest, where it lives in shallow tunnels under fairly large stones. In the Mount Lofty Ranges of South Australia, where most of my field observations have been made, it is found in fair numbers at the edge of moderately dense forest of stringybark (*Eucalyptus obliqua*), or occasionally blue-gum (*Eucalyptus leucoxylon*), in preferably damp or slightly damp situations. I have also collected this species in the Grampians of Victoria, and at the western end of Kangaroo Island, South Australia.

Males may readily be distinguished from the females by the former having the dorsal surface of the abdomen dull grey, finely granular, whereas in the females the dorsal surface of the abdomen is darker, smooth and polished.

The specimens of this species (captured up to November 1953) in my collection are as follows:

Serial Number	Number of Specimens	Locality	Comments
S 3	6	Workanda Creek, National Park, Belair, Mount Lofty Ranges, South Australia, 30th March, 1937	Parasitized by larval *Leptus* sp. (n. sp.) (Acarina Erythraeidae)
S 2	14	Mount Osmond (5 specimens) Workanda Creek (9 specimens) (Mount Lofty Ranges), April-May 1938	Kept in captivity. Some lived 2 months
S 4	4	Workanda Creek, 24 July 1938	Two mature; two juvenile
S 5	2	Waterfall Gully, Mount Lofty Ranges, 24 August 1938	One adult; one immature
S 7	1	National Park, Belair, 11 April 1939	
S 1	1	Cherry Gardens, Mount Lofty Ranges, 30 April 1939	Pectines removed experimentally. Lived some weeks. Was probably given insufficient water
S 8	3	Rocky River, Kangaroo Island, 29 December 1939	Two adult males; one immature
S 9	1	Workanda Creek, S. Aust., 13 December 1947	Mature. Lived 7½ months in captivity

Serial Number	Number of Specimens	Locality	Comments
S 10	1	Fish Falls, Grampians, Victoria, 4 January 1948	Mature female
S 11	1	Workanda Creek, 1 August, 1948	Dried carcase
S 12	1	Workanda Creek, 10 October 1948	Mature. Lived 4 months in captivity
S 27	1	Workanda Creek, 13 November 1948	Mature. Lived 9½ months in captivity
S 13	1	Workanda Creek, 22 May 1949	Mature. Lived 13 months in captivity
S 24	1	Workanda Creek, 23 October 1949	Mature. Lived 6 months in captivity
S 14	1	Workanda Creek, 30 July 1950	Mature. Lived 2½ months in captivity
S 25	1	Workanda Creek, 21 May, 1950	Mature. Lived 6 months in captivity
S 26	1	Workanda Creek, 12 November 1950	Lived 2 weeks in captivity
S 28	1	Workanda Creek, 18 February 1951	Parasitized by larval *Leptus* sp. (Erythraeidae), Acarina
S 15-18 19 A, B	6	Workanda Creek, July September, October 1951	Sexual activity noted. See detailed report below
S 20, 21	2	Workanda Creek, 16 November 1952	S 21 (female), lived 2 months. S 20 (male), still alive (September 1954), i.e., has lived 22 months in captivity
S 22, 23	2	Workanda Creek, 30 August 1953	
S 43	6	Workanda Creek, 1 November 1953	Three specimens are still in captivity. Four mature, 2 immature

REARING EXPERIMENTS

It will be noted from the above data that since 1937 a number of attempts has been made to keep scorpions in captivity. So far it has been possible to keep adults alive up to 22 months in captivity. Since 1947 I have kept them in cylindrical glass pots, with overlapping (not sealed) lids. These pots are 15 cms. across by 10 cms. high and contain a little damp soil. Various insects and spiders have been given for food. So far no insect or arachnid that I have given them has been refused. I have fed them on moths, spiders, flies, beetles, etc. Generally moths or beetles are the most convenient. Of the beetles I generally give various species of Carabidae, *e.g. Clivina* sp., etc., or else *Adelium* sp. (Tenebrionidae). The scorpions appear to be able to distinguish an insect's (etc.) movement from that of another scorpion; as long as the insect moves at moderate speed the scorpion immediately seizes it, unless it is bloated with food or else the weather cold. The scorpions invariably sting their prey to subdue it as soon as it is captured, often stinging it twice in different sites before the struggles cease. If one scorpion walks over another, as often happens in the confined space of the pot, it is very rare for any evidence of resentment to be aroused. Skirmishes between these scorpions are rare. In its manner of stinging its prey immediately on capture *Urodacus abruptus* differs markedly from the large Philippine forest scorpion (*Palamnaeus longimanus* Herbst?) as described by Schultze. Schultze (1927) recorded that he had never seen this latter scorpion sting its prey—*e.g.*, cockroaches—in order to subdue it. The prey was held clear of the ground, and eaten while still struggling. Schultze stated that "I believe that the poisonous stinger is used only as a defensive weapon against its enemies." In its habit of stinging its prey in order to subdue it *Urodacus abruptus* resembles *Buthus occitanus*, as recorded by Fabre, rather than Schultze's species.

Urodacus abruptus can survive a considerable time without food. I have kept an adult male specimen in captivity for eight months without food, after which period it was given a housefly to eat. Since then it has been kept a further nine months without food, and remains at the time of writing (September 1954) active and plump, apparently quite healthy. When a group of scorpions is kept in captivity, even if both sexes are present, they generally live amicably. However, if food is not given they occasionally practise cannibalism. These scorpions are inactive by day, but become active at night. On inspecting the pot one morning one may find that one scorpion has disappeared, and a plump cannibal is finishing off the last of its fellow. I have not actually seen the beginning of such a meal, so am unable to say what circumstances precipitate it, or whether the sting is used in such an encounter, but in view of the general feeding habits of this scorpion it appears probable that it is. In such acts of cannibalism it is always one of the smaller specimens that succumbs. Usually the meal is almost over by the time it is discovered. I make a practice of counting up the number of scorpions in the pot at each observation. Usually the only parts of the vanquished that remain after such a meal are the pedipalpal claws (hands) and the vesiculus, with perhaps a few segments of the tail and the pedipalps, and part of the dorsal surface of the cephalothorax. The remainder disappears completely. When small beetles are given as food only the hardest parts of the insect remain after the meal, *e.g.*, the elytra and the exoskeleton of the thorax. Moths and spiders disappear completely, except the scales of the former. With moths the scorpion frequently commences to eat at the head. At the present time I do not usually feed the scorpions oftener than once per month. It is probably on account of this that I have more lately seen more frequent evidence of cannibalism. Even so, scorpions may remain in a pot for several months without feeding before one of the smaller specimens is eaten. There is no evidence that such cannibal meals commence in sexual activity, in fact, as remarked before the victims are immature specimens.

Water is needed more frequently by this species of scorpion. In the cooler months I generally give water about once per month. The floor of the pots is covered with a layer of earth, which is kept just damp. In the summer months water is given more often, usually about once per week. The water may be dropped on to the mouth parts by a dropper, or else pledgets of cotton wool soaked in water are placed in the pot. In the latter case, when the pot has become very dry, the scorpions will cluster around the pledget almost immediately, tearing at it with their chelicerae. They frequently give the appearance of eating the water rather than drinking it.

As yet parturition has not been observed in *Urodacus abruptus*, even though females have been observed in captivity with gross abdominal distension. Certain details of sexual behaviour have however been observed, and will be recorded in the following section.

SEXUAL BEHAVIOUR

Experiment S 15-19. On 29 July 1951 three scorpions were captured at Workanda Creek, National Park, Belair, South Australia. The two larger scorpions were placed in a small "wax vesta" tin. Nothing unusual was noted at the subsequent occasional examinations, until 10 September, a warm day, when many "scuffling" noises were heard emanating from the tin. On opening the tin it was found that the pair were holding "hands" as in a typical promenade à deux as described by Fabre. The pair were transferred to a glass pot as described above, and that manoeuvre separated them. On the morning of 11 September it was seen that the pair had resumed the promenade à deux position. No fresh observations could be made, and on the morning of 12 September the pair had separated again. On 13 September two fresh adult scorpions from Workanda Creek were

added to the pot. On 14 September further evidence of sexual activity was noted; a male had grasped a female askew, holding the passive female sideways on. On 15 September all scorpions were separate.

On 24 September I recorded: No further attempt at a promenade à deux has been observed. The scorpions do not appear to resent in any way one of their fellows climbing over them—this applies equally well to males and females. By day they are sluggish, but when one switches on the light at night to observe them they are at the alert, poised on their legs and with the telson up, walking or stalking around, manoeuvring the pectines delicately over the crumbs and lumps of soil in the pot, and demonstrating very clearly the tactile function of the pectines.

On 8 October 1951 I recorded: No further sexual activity has been observed. The five scorpions are in the pot on my study table, and are under pretty constant observation. The weather is warm today and perhaps this accounts for today's resumption of sexual activity. The soil in the pot has become rather dry. At 10.10 p.m. I noted: The couple rests for about half a minute, with fingers clasped (see fig. 1), and then the "orgasm" recommences. The male pushes the

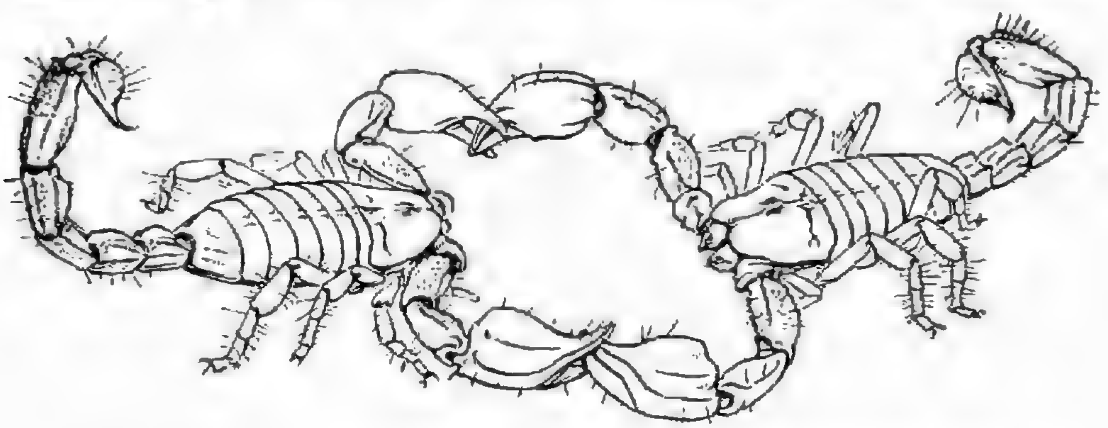

Fig. 1

Normal position of the promenade à deux in the scorpion *Urodacus abruptus*. Male to left. Note the more erect telson of the male, that of the female being semi-erect.

female against the glass side of the pot and wags his tail up and down in seeming attempts to climb through her "arms" and push his genital operculum against her mouthparts. The pectines move about seemingly to serve as tactile organs. His mouthparts work at the same time, the chelicerae being extended. His first legs are planted on her chelicerae, but she makes no effort at resistance or counter-movement. He then pulls her backwards. The frenzy then starts again, the male's tail works vigorously, and at the next attempt he manages to climb further, in fact almost right through her arms (10.15 p.m.) (see fig. 2). One arm of the male then disengages, the male circles rapidly around, still retaining the grip of his other pendipalp (fig 3) until he faces the female again. The process then starts all over again. In the extreme position of the sexual lunge the pedipalpi of the female are twisted back behind the cephalothorax, and completely extended, so that the surface of the pedipalpi that is normally ventral faces dorsally and anteriorly (fig. 2). The mouthparts of the female remain quite impassive, and she remains no more than placidly co-operative during the whole of the process.

10.30 p.m.: The male nibbles at the female with one chelicera and then the other in quick succession, or with both simultaneously, at either her cephalothorax or the claws of her pedipalpi. Whilst doing this the male brandishes his

tail erect, and waves it about freely as though to heighten the "orgasm." The tail of the female remains flaccid, curled, usually rest on the soil, or else slightly raised, but it is never raised at more than 45° above the horizontal.

10.35 p.m.: The activity continues almost unceasingly. In one manoeuvre the male grasped the female by her wrong (contralateral) claw. The male soon corrected this. The female appears willing to go wherever the male will push or pull her.

10.37 p.m.: The male grabs the female's tail with one of his pedipalps and leads her around by it, pulling her tail over her cephalothorax. At this insult she opens her claws a little, but makes no effort to attack or resist the male, and she soon desists. The male soon after gets tangled up, grabbing anywhere at the female, but after some manoeuvring resumes the standard face to face position, again holding the female's pedipalpal "fingers" between his. Again the male attempts to climb through the female's "arms" on to her back, as in fig. 2.

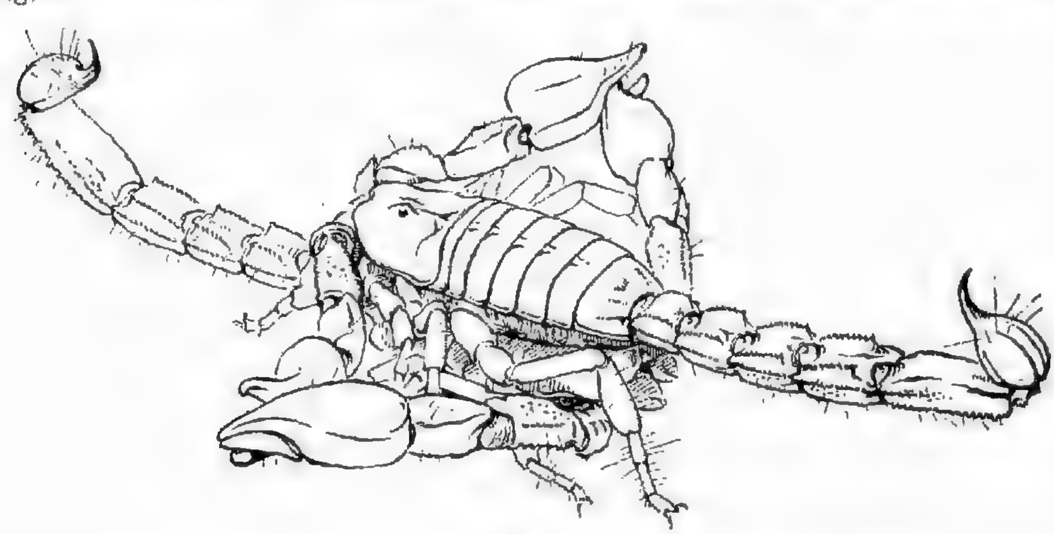

Fig. 2
The sexual thrust, in which the male forces himself through the pedipali of the female. The full depth of the thrust has not yet been reached.

10.41 p.m.: While attempting to climb through the female's "arms" the male nearly succeeded in pulling her over on to her back, using the hind end of her abdomen (mesosoma) as a pivot. Her cephalothorax was lifted clear of the ground, and sharply retroflexed upon her abdomen. The pair then returned to the standard face to face position (as in fig. 1), and the furious "kissings" and lunges started over again.

10.50 p.m.: An attempt was made at photography. The excessively bright lights necessary caused a cessation of sexual activity, which was never resumed.

OTHER BEHAVIOUR

These notes continue the narrative of the above group of specimens.

9 October 1951: Weather cooler. No further activity.

16 October: One female has died (not the one of the mating pair) from no apparent cause. Water was given. The surviving scorpions drank greedily.

On 27 October a further large female scorpion from Workanda Creek was added to the pot. By 25 November 1951 this female had died, for no apparent reason, and was removed from the pot. Water was given to the others, in the

form of a cotton-wool pledget soaked in water. The scorpions drank greedily, tearing at the cotton-wool with their chelicerae. On 16 December a spider was added as food. This was soon eaten by one of the scorpions. On 18 December it was observed that in the preceding two days one scorpion had been eaten by one of its fellows, and only the claws of the pedipalpi remained of the victim. On 21 and 29 December insects were given and were promptly eaten.

On 21 January 1951 all three scorpions appeared healthy. A moth was added to the pot. A male scorpion seized this immediately, stung it twice within a few seconds, and made off with it. But in doing so the male aroused the interest of a large female scorpion, which seized the moth from the male and carried it off. The male attempted two or three times to retrieve his meal from the female, but without success. The thwarted male attempted to pick a fight with the other male in the pot, but the latter maintained his dormant attitude and would not fight. Although stings were flourished in these encounters no scorpion actually used its sting on any other.

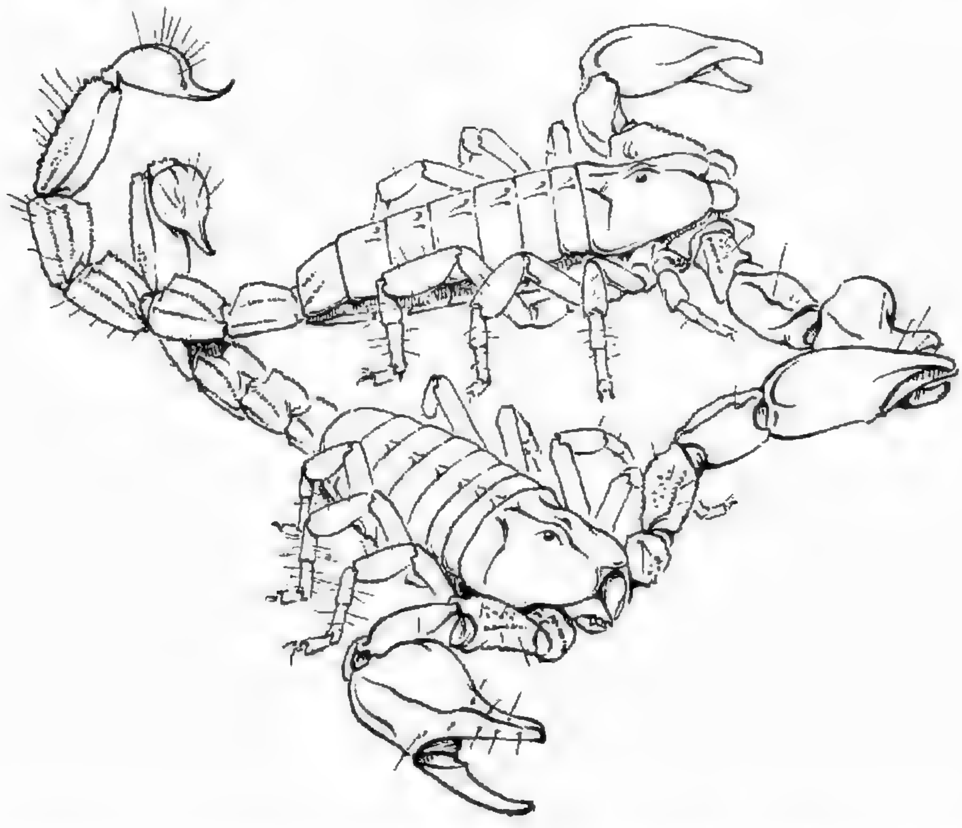

Fig. 3

The position shortly after the completion of the sexual thrust. The male has lost the grip with the left pedipalp, and is circling to resume the normal stance of the promenade à deux.

On 22 January 1952 a tented piece of bark was dropped into the pot. The female immediately retired into the cavity beneath this. On 21 March 1952 or shortly before this female died. Two males remained in the pot. These were fed and watered about once per month. On 16 October 1952 one of the males died. The other male remained healthy. On 19 September 1952 a freshly captured adult female had been added to the pot. No sexual activity was observed between these scorpions. Nothing unusual was observed for the remainder of the year. Food and water were given occasionally, and were always accepted.

On 23 January 1953 the female commenced to adopt a stance which had not been observed previously. My notes record: Female appears parturient, judging by the size of the abdomen. She elevates the posterior end of the abdomen, with the tail drooping forward (see fig. 4). She remains thus for an hour or so at a time, and then slumps to a flaccid heap on the soil. No attempt has been made to molest the male, or vice versa.

On 25 January she resumed the same position (as fig. 4) from noon until nearly 4 p.m. She remained flaccid on the soil until 6 p.m., then resumed the fig. 4 stance for three hours, after which she disappeared under the tented piece of bark. At 10 p.m. she emerged again.

This stance of elevation of the abdomen was resumed periodically but only on very hot days, and after 25 February 1953 was not observed. When she assumed her position she would climb on a piece of bark or a lump of soil in an apparent attempt to get as much elevation as possible.

On 31 March 1953 the female (S 18) died. By 13 April 1953 or shortly before the male (S 19A) died.

COMMENT ON THE SEXUAL BEHAVIOUR

I have not been able to find any record of the sexual lunges described above for *Urodacus abruptus* in the published descriptions of mating behaviour of scorpions. Millot and Vachon (1949), in an excellent review of the existing knowledge, state: "We owe the essential part of our knowledge to Fabre, in his Souvenirs Entomologiques . . . . On a single occasion he was able to catch a glimpse of ('entrevoir') the solution of the difficult problem of fertilization: the male, lifting his belly, slides under the female, the pectines interdigitating, the hands still constantly gripped. Well before Fabre, Maccary, in September 1809, had seen a male, after some initial failures, attack the 'forehead' of the female, turn her over on her back, and remain about five minutes upon her. In 1891 Brongniart and Gaubert reported that Marés, in Algeria, had surprised coupled scorpions, belly to belly, the pectines interdigitating." Millot and Vachon then proceed to discuss the mechanism of fertilization.

It is possible that the sexual lunges or thrusts recorded above for *Urodacus abruptus* were seen by Maccary in his "vaines tentatives (préludes)," for the Languedocian scorpion (*Buthus occitanus* (Amor.)). However, no more precise record than this appears to have been made previously.

The observations described above for *Urodacus abruptus* suggested that the male was attempting to push the female over onto her back, and in fact he nearly succeeded in doing this on one occasion during the observations. It is expected that in copulation the animals remain belly to belly, chelicerae to chelicerae, tail to tail, the male on top. The failure for actual copulation to occur may have been due to (1) disturbance from the bright lights in the attempts at photography; (2) inadequate facilities for the male to exert pressure on the female in his attempt to turn her on to her back. It is expected that in nature copulation normally occurs in the shallow tunnels in which these scorpions live. In such tunnels it would be possible for the male to exert considerable force with his legs braced against the sides. On the relatively flat earth surfaces in the rearing jars the male's legs were quite extended during the moments of maximal pressure in the sexual thrusts, and obviously the male was at the limits to which he could force himself.

The writer has since constructed an artificial tunnel of clear plastic, coming off a box of the same composition ("Perspex"). Some vertical scratches line the tunnel to aid the male in his bracing. It is hoped that the restricted space of this tunnel will provide suitable conditions for copulation to occur and be observed. As our scanty knowledge on this subject would indicate, opportunities to observe these phenomena are few and fleeting.

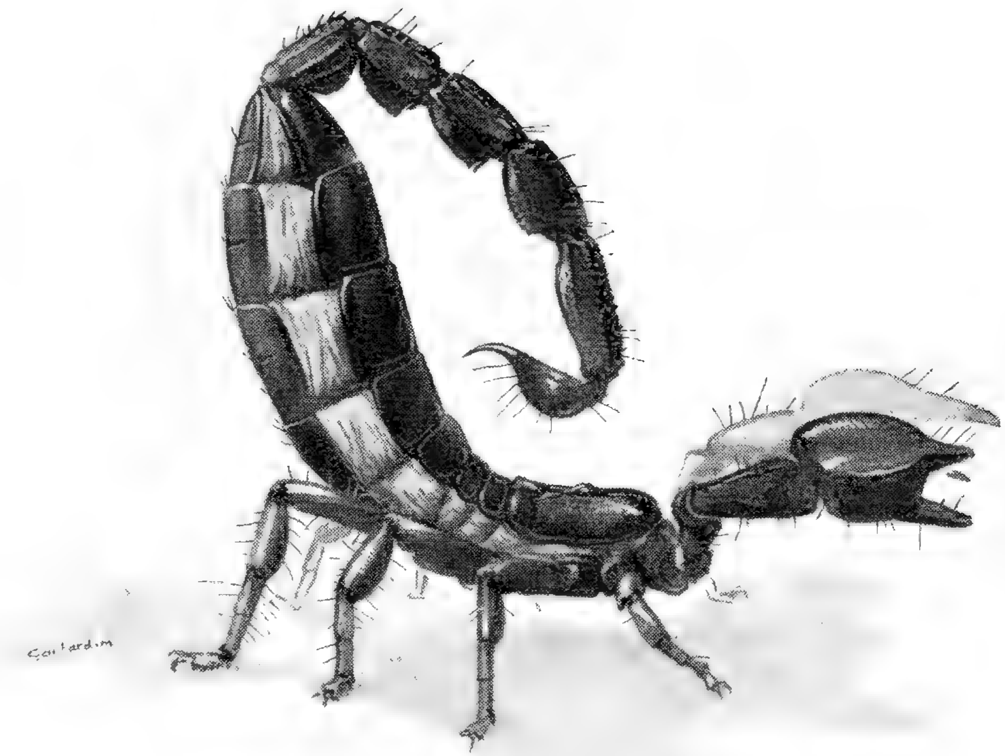

Fig. 4
The abdominal elevation seen in a female *Urodacus abruptus* in the heat of summer, under humid conditions.

It will be noted that in the mating dance of *Urodacus abruptus* the female keeps her tail comparatively flaccid—her tail is either loosely coiled behind her, semi-erect, or else lies flaccidly horizontal on th soil, loosely coiled. In this characteristic *U. abruptus* differs from other scorpions whose mating dances have been described, *e.g. Buthus occitanus* (see Fabre 1923), or *Buthotus alticola* (see Serfaty and Vachon 1950). In both of these latter species the female takes a slightly more active part in the mating dance, and in them the tail is described as remaining erect in both sexes.

It is of interest to note the "kissings" in *U. abruptus*—in which the male nibbles harmlessly at the "face," etc., of the female with his chelicerae. Since scorpions are but little changed in structure since Silurian times, it may reasonably be surmised that this and other sexual behaviour described extends back to a geological period of great antiquity.

COMMENT ON THE ABDOMINAL ELEVATION

It was at first thought that the elevation of the rear part of the pregnant female was indicative of imminent parturition. As however parturition did not ensue in the female described this surmise was rendered less likely. Schultze (1927) observed parturition in one female of the large Philippine forest scorpion (*Palamnaeus longimanus* Herbst?) recording that in this process it "held its body in a peculiar position, somewhat raised and bent or curved in the middle into a convex shape but with the chelipeds drawn up close to the body." This latter position is unlike the one described above for *U. abruptus*. I have observed males also of *U. abruptus* to adopt a similar attitude, on hot days in December 1953, when conditions in the pot were hot and humid. However in the male the attitude was less pronounced than in the female. It would appear most likely therefore that the stance described is an effort to lift the stigmata free from the humid layer of air and soil, when the scorpion's metabolism is increased by a hot environment.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. Max Vachon, of the Muséum National d'Histoire Naturelle, Paris, for advice and encouragement. The illustrations to this article were prepared by his artist, M. Gaillard, from sketches and specimens forwarded by myself (Specimens S2 and S9, from Mount Osmond, South Australia, and Workanda Creek National Park, Belair, South Australia).

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A NEW SPECIES OF ATRIPLEX (ATRIPLEX SPONGIIVALVIS AELLEN)

BY PAUL AELLEN (BÂSLE)

Summary

Atriplex spongiivalvis Aellen spec. nov.
Frutex 30 cm. altus valde lignescens multiramosus; surculi juveniles dense lepidoti demum glabrescentes. Folia superiors parva, 5 mm. longa, 4 mm. lata, ovatorhombica, utrinque 1-3-dentata, antice late cartilagineo-mucronata, basi rotundata vel cuneata, sessilia vel breviter subpetiolata, consistentia crasse coriacea, imprimis subtus dense lepidota. Flores masculi et feminei mixti 1-3-ni (omnino) axillares sessiles, dense lepidoti. Perianthium florum femineorum 2.5 mm. longum, 2 mm. latum, obovato-rotundatum, antice latissimum, ibique dentibus 3 (-5) obtusis vel acutis prolongatis provisum, dente intermedio laterales superante, in parte inferiore magis spongioso-incrassatum, in medio continue gibberoso-coronatum, gibberibus 3-5 obtusis vel acutiusculis leviter arcuatim dispositis, non tubulosum, sessile ad 2/3 connatum. Pericarpium tenuiter membranaceum. Semen atrofusum, oblongum, 1 mm. ad summum diametro. Stigmata minuta, sessilia. Radicula embryonis lateraliter ascendens.

A NEW SPECIES OF ATRIPLEX (ATRIPLEX SPONGIIVALVIS AELLEN)

By Paul Aellen (Basle)
(Communicated by C. M. Eardley)
[Read 14 October 1954]

Atriplex spongiivalvis Aellen spec. nov.

Frutex 30 cm. altus valde lignescens multiramosus; surculi juveniles dense lepidoti demum glabrescentes. Folia superiora parva, 5 mm. longa, 4 mm. lata, ovato-rhombica, utrinque 1-3-dentata, antice late cartilagineo-mucronata, basi rotundata vel cuneata, sessilia vel breviter subpetiolata, consistentia crasse coriacea, imprimis subtus dense lepidota. Flores masculi et feminei mixti 1-3-ni (omnino) axillares sessiles, dense lepidoti. Perianthium florum femineorum 2·5 mm. longum, 2 mm. latum, obovato-rotundatum, antice latissimum, ibique dentibus 3 (–5) obtusis vel acutis prolongatis provisum, dente intermedio laterales superante, in parte inferiore magis spongioso-incrassatum, in medio continue gibberoso-coronatum, gibberibus 3-5 obtusis vel acutiusculis leviter arcuatim dispositis, non tubulosum, sessile ad 2/3 connatum. Pericarpium tenuiter membranaceum. Semen atrofusum, oblongum, 1 mm. ad summum diametro. Stigmata minuta, sessilia. Radicula embryonis lateraliter ascendens.

South Australia: Eyre Peninsula—Cowell and Kimba Districts; June 1937, *J. C. Gross.* (Type in the Herbarium of the Waite Agricultural Research Institute and in Herbarium P. Aellen.)

Die neue Art ist zunächst verwandt mit *Atriplex prostrata* R. Br. und *A. Acutibractea* Anderson. Die beiden Arten werden jedoch als einjährig beschrieben, während *A. spongiivalvis* ein stark verholzter, niederer Strauch ist. Die Perianthe von *A. prostrata* tragen keine Anhängsel, und die kegelförmigen Höcker auf den Perianthen von *A. acutibractea* stehen einzeln, sind einfach oder höchstens zweigeteilt, und sind nicht—wie bei *A. spongiivalvis*—kräftig und zu einem geschlossenen Kranz gruppiert.

Fig. 1 Fruiting bracteoles of *Atriplex spongiivalvis* Aellen.

This new species of saltbush is most closely related to *Atriplex prostrata* R. Br. and *A. acutibractea* Anderson. These two species, however, are described as annuals, whilst *A. spongiivalvis* is a decidedly woody, low shrub. The fruiting bracteoles of *A. prostrata* bear no appendages, and the conical tubercles on the bracteoles of *A. acutibractea* are isolated, being simple or at most divided into two, and are not—as in *A. spongiivalvis*—robust and grouped into a closed wreath. (Translation C.M.E.)

THE GENETIC AND SYSTEMATIC STATUS OF EUCALYPTUS HUBERIANA NAUDIN, E. VIMINALIS LABILL. AND E. AROMAPHLOIA PRYOR AND WILLIS

*BY L. D. PRYOR**

Summary

Eucalyptus populations in western Victoria and South Australia previously often referred to *E. Huberiana* are considered as a result of progeny testing and careful field collecting, to be a segregating hybrid swarm between *E. viminalis* and *E. aromaphloia.* The development of this swarm may have coincided with a relatively recent arid climatic cycle.

THE GENETIC AND SYSTEMATIC STATUS OF EUCALYPTUS HUBERIANA NAUDIN, E. VIMINALIS LABILL. AND E. AROMAPHLOIA PRYOR AND WILLIS

By L. D. Pryor *

[Read 14 October 1954]

SUMMARY

Eucalyptus populations in western Victoria and South Australia previously often referred to *E. Huberiana* are considered as a result of progeny testing and careful field collecting, to be a segregating hybrid swarm between *E. viminalis* and *E. aromaphloia*. The development of this swarm may have coincided with a relatively recent arid climatic cycle.

Eucalyptus Huberiana [1] is a species which in common with a number of others, was described from a single planted specimen growing in Europe. In this particular case, Naudin described it from a tree seven years old growing at Nice, France. Naudin makes the remark that "One might take *E. Huberiana* for a rather slender form of *E. viminalis*, but it can be easily distinguished from it by the following characteristics. Its inflorescence consists of axillary umbels rather shortly pedunculate, composed of seven very small pedicillate flowers . . ." In addition Naudin says, ". . . I do not know . . . to what part of Australia it is native." The description given, like that of many species described early in the history of the systematic treatment of a genus, omits some features which have later been found critical in determination, and includes others which are of little diagnostic value.

In applying a name such as this therefore, to a population of *Eucalyptus* in its natural habitat, there are very considerable risks, and unless characters are included in the description which for the particular category concerned happen to be critically distinct, there is danger of confusion in continuing to employ such names.

The uncertainty about the application of the name "*Huberiana*" is shown by its varying use over a considerable period. Maiden, "Critical Revision" (3, 173) says, "It is allied to, or identical with, *E. viminalis*." On the other hand, Blakely (1934) gives it specific rank and assigns specimens from a good many diverse localities to it. Burbidge (1947) reduces it to *E. viminalis* var. *Huberiana*.

In connection with another but now discarded species name, *E. Mazeliana*, described by Naudin, Maiden says, "If *E. Mazeliana* is not *E. viminalis* and not *E. Smithii*, I cannot say what it is." The same remark might well have been made of *E. Huberiana*. The description, however, is adequate to place *E. Huberiana* as having a strong affinity with *E. viminalis*, or at least, with species in Blakely's series Viminales.

It has become the practice to refer to *E. Huberiana*, trees falling clearly within the series Viminales, which are close to *E. viminalis* in many respects but differ in having at least some flower clusters with more than three flowers, and with some rough bark varying from a relatively small amount at the butt to a large amount extending to the secondary branches. A significant thing which will be referred to again later, is that *E. Huberiana* is often described as having a geographic range co-extensive with *E. viminalis*. Burbidge specifically refers to this by saying, "Distribution is the same as in *E. viminalis*." Within the series Viminales this is exceptional as the "good" species of the series, *viz.*, *Bauerlenii*, *quadrangulata*, *Macarthuri*, *Smithii* and *Benthamii*, each occupy localities which which are ecologically and generally geographically distinct from *E. viminalis*, and are certainly not co-extensive with it.

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* Department of the Interior, Canberra, A.C.T.

(1) Nomenclature as in Blakely (1934), "A Key to the Eucalypts."

EUCALYPTUS VIMINALIS

The type of E. viminalis was described by Labillardiere from a specimen taken at Cape Van Diemen, Tasmania. There is little doubt that the type, which had three-flowered inflorescences, was taken from an individual which belonged to an extensive *Eucalyptus* population within the Macrantherae in which the predominant characters are that the inflorescences are exclusively three-flowered, the bark is smooth and decorticating except possibly for a very small amount at the base, the juvenile leaves are opposite, sessile, not glaucous, and somewhat stem-clasping for a large number of pairs. On this basis, the population called *E. viminalis* makes up one of the widespread species of the genus (fig. 1). It

Fig. 1
The present distribution of *E. viminalis.*

has become the practice, in addition, to refer to this species individuals which differ in some degree from the type description. This, of course, is necessary in all systematic work because the type specimen is from a single plant which cannot be absolutely identical with the population, and therefore it becomes a matter of opinion as to whether another given individual should be referred to that species. In accordance with this, Maiden accepted the idea that individuals which differed only in having a good deal of rough bark on the main trunk might be included, and also that those with inflorescences with four and five and even more flowers, but otherwise similar, could be included.

With regard to this latter point, however, he says, in making a comparison *E. viminalis* with *E. Smithii* (3, 180) ". . . *E. Smithii* is multi-flowered, while *E. viminalis* usually has flowers in threes, while it much less rarely has them in fours and even more, but while multi-flowered individuals may be abundant in a particular district, they are few in comparison with the total of the normal form."

Emphasis is given to the two points of bark and number of flowers in the inflorescence. In both cases, but particularly in the inflorescence, the presence of flower clusters of more than three, but less than seven, in individuals assigned to a species which is ordinarily over a great portion of the population exclusively three-flowered, is found invariably associated with the hybridism. *E. viminalis* hybridizes freely, as deduced by progeny tests, with many other species belonging to Blakely's section Macrantherae (Normales). Those which have been established on this basis or on grounds of morphology are as follows:—

	Locality of Occurrence	Assessment
E. viminalis x *E. glaucescens* -	Tinderry Mountains - - -	- P.T.
	Munyang - - - -	- M.
	Tingiringi - - - -	- P.T.
x *Dalrympleana* -	Extensively in Tasmania, Victoria and N.S.W. - - - -	- P.T.
x *E. rubida* - -	Near Armidale, New England Tableland and near Cooma, Southern Tablelands -	- P.T.
x *E. maculosa* -	A.C.T. and Mount Wilson, N.S.W. -	- M.
x *E. parvifolia* -	Big Badja, N.S.W. - - -	- P.T.
x *E. ovata* - -	Myponga, S.A. - - -	- P.T.
x *E. bicostata* -	Jenolan, N.S.W. - - -	- M.
x *E. globulus* - (= *E. unialata*)	Tasmania - - - -	- P.T.
x *E. Maideni* -	Araluen - - - -	- P.T.
x *E. goniocalyx* -	Mount Coreeudgy, Blue Mountains -	- M.
x *E. nitens* - - (= *E. Badjensis*)	Badja - - - -	- M.
x *E. Bridgesiana* -	A.C.T., Lake George - - -	- P.T.
x *E. elaeophora* -	Seven Hills and Houghton, S.A. -	- P.T.
x *E. Cordieri* -	Burra Rd., Southern Tablelands -	- P.T.
x *E. Macarthuri* -	Planted trees, A.C.T. - - -	- P.T.
x *E. cinerea* -	Lake George, N.S.W. - -	- P.T.
x *E. nova-anglica* -	Deepwater, New England Tableland	- M.
x *camaldulensis* -	South Yarra, Vict. - - -	- P.T.

Note: P.T. = Progeny Test. M. = Morphology only

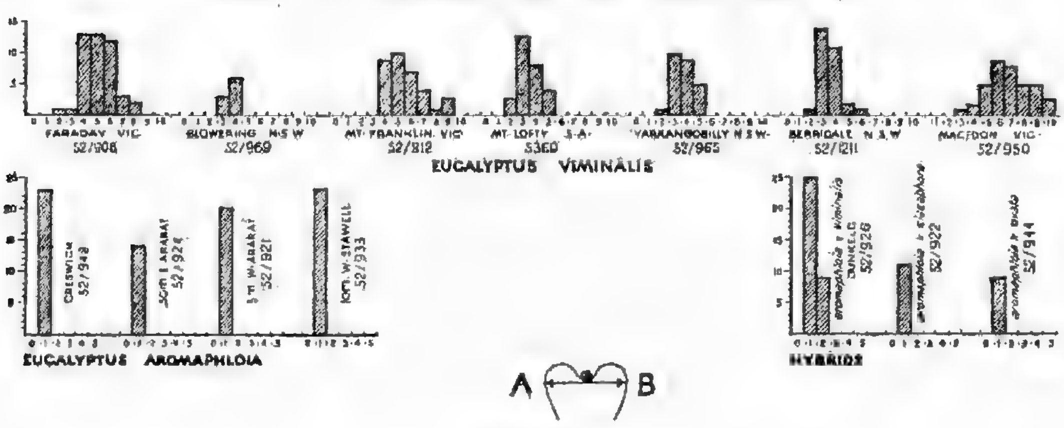

Fig. 3 a

Histogram based on the measurement A–B of the leaf base (shown in the inset) which provides a measure of the extent to which the leaf is stem-clasping. All populations of "pure" *E. viminalis* are distinctly stem-clasping. On the other hand, all populations of *E. aromaphloia* are tapered to a very short petiole. The hybrid *E. aromaphloia* x *E. viminalis* shows some degree of segregation for this character.

The explanation for this is two-fold. Firstly, because *E. viminalis* has such a wide geographic distribution it comes in contact in the field with many other species which have a more restricted distribution, and secondly, it is evidently capable of hybridizing with a wide range of species in the broad systematic group to which it belongs.

Hybrids are common between many *Eucalyptus* species where a junction in species area occurs in the field (Pryor, 1953). In a great many cases this is at the meeting point of two distinct habitats. In such circumstances the hybrid zone is narrow, or even almost linear and composed only of scattered trees. This is true of many of the hybrids of *E. viminalis* listed, but also, *E. viminalis* is a component of much more extensive apparent hybrid swarms. Over the whole range of distribution of *E. viminalis*, there are three main areas in which apparent hybrid swarms occur:

(a) The New England Tableland.

(b) Towards the upper altitudinal limits of *E. viminalis* particularly surrounding the Kosciusko area and surrounding the central plateau of Tasmania.

(c) The Mount Lofty Ranges and south-east of South Australia.

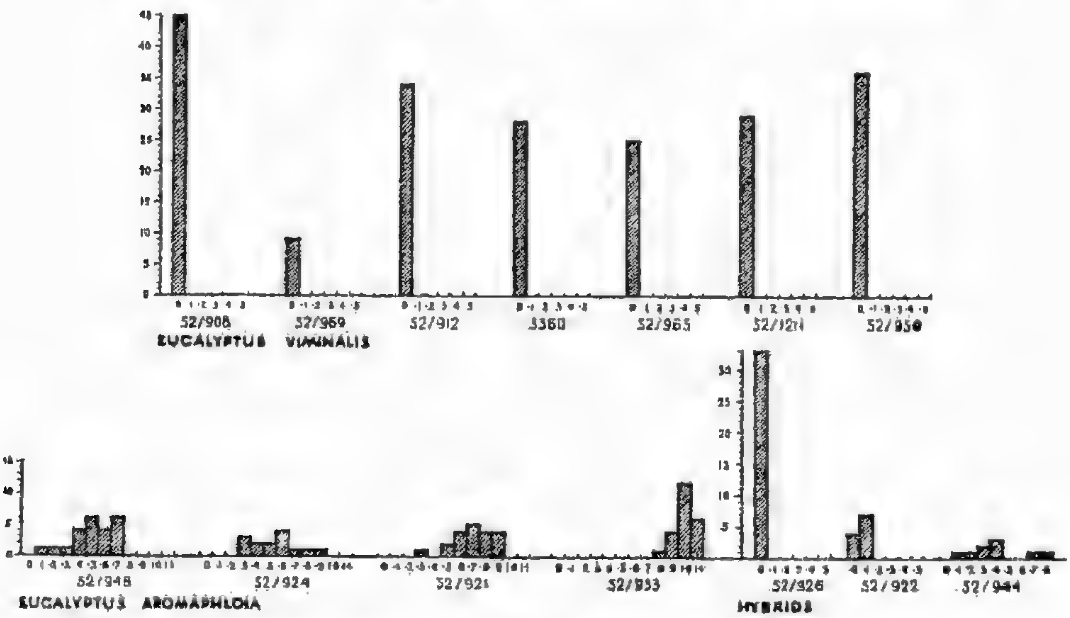

Fig. 3 b

Shows the same progenies assessed on the distance by which each of the tenth pair of leaves is separated one from the other. *E. viminalis* in all progenies is strictly opposite. *E. aromaphloia* is distinctly separated and therefore the leaves are not opposite. In the hybrid *E. aromaphloia* x *E. viminalis* the opposite leaf character persists apparently as a dominant and no segregation is disclosed, but some segregation is shown in the progeny *E. aromaphloia* x *E. elaeophora*.

In the case of the New England Tableland, it is easy in most cases to deduce convincingly which species other than *E. viminalis* have contributed to the hybrid swarm. There is a considerable number of species on the New England Tableland occupying various habitats, and still present, which either have been observed to hybridize with *E. viminalis* or are theoretically able to do so. For this reason, therefore, it seems that Blakely's remark with regard to *E. Huberiana*, "It is widely distributed on the mainland and exceedingly plentiful on the New England Tableland where it reaches its optimum . . ." is easily explained, apart from

other reasons which will be discussed later, by the fact that there, there are several species in contact with *E. viminalis* with which it can readily hybridize, *e.g., E. nova-anglica, E. acaciaeformis, E. Nicholi, E. Deanei, E. rubida*. Both *E. nova-anglica* and *E. acaciaeformis* could provide combinations which could satisfy the second part of Blakely's description "with a smooth deciduous bark except for a few feet at the base, *but sometimes rough-barked to the secondary branches, especially in the Tamworth and Guyra-Armidale district*."

The position is also fairly clear at the upper altitudinal limit where extensive hybridizing between *E. Dalrympleana* and *E. viminalis* leads to hybrid swarms over a considerable altitudinal range, and results in a marked blurring of the boundaries between the two species. This is in a way that is relatively uncommon and has led to difficulty in the easy recognition of *E. Dalrympleana* as a species. (*E. Dalrympleana* is also three-flowered, however, so this combination is not referred to as *E. Huberiana*).

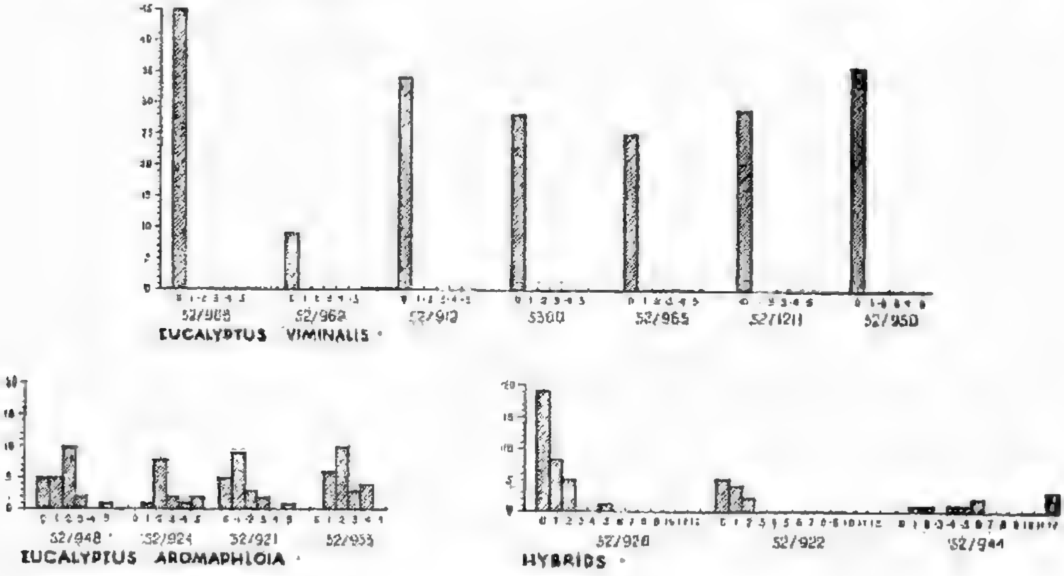

Fig. 3c

The same progenies assessed on the petiole length at the tenth pair of leaves. *E. viminalis* in all progenies is strictly sessile, while *E. aromaphloia* is at this stage changing over to a petiolate condition, although the petioles are frequently quite short. The progeny from the hybrid *E. aromaphloia* x *E. viminalis* shows marked segregations for this character and so does the progeny from *E. aromaphloia* x *E. elaeophora*. *E. elaeophora* has sessile juvenile leaves as in *E. viminalis*.

In the Mount Lofty Ranges and the Mount Gambier and Naracoorte area of South Australia, the position is the same so far as the appearance of hybrid swarms is concerned. Populations exist which have many of the characters of *E. viminalis* but are modified in three main ways.

Firstly, by the development of inflorescences of four, five and seven flowers; secondly, with a varying amount of rough bark from almost clean to individuals with secondary branches quite rough; and thirdly, with juvenile leaves which become sub-opposite after ten to fifteen pairs, and which are contracted at the base and even shortly petiolate. This pattern of variation is identical with that found in hybrid swarms elsewhere. The difficulty in adopting the occurrence of a hybrid swarm as the explanation for this variation in South Australia has been (since it is highly probable that *E. viminalis* cannot hybridize with species other than those in the Macrantherae-Normales) that there are very few such species either in the Mount Gambier-Naracoorte area or the Mount Lofty Ranges with which it could hybridize. Those which do exist could not contribute the characters

necessary to account for this particular swarm. Those available are limited to *E. rubida, E. ovata* and *E. elaeophora.* Amongst these, *E. elaeophora* is rough-barked, but its juvenile leaves alone would produce variations in another direction, and cannot be used to account for the swarm. Likewise *E. camaldulensis* of the Exsertae cannot be assumed as the second parent.

The position is met completely, however, by the recognition over a range from central Victoria to the south-east of South Australia of a hitherto undescribed species, now called *E. aromaphloia.* This is described elsewhere (Pryor and Willis 1954).

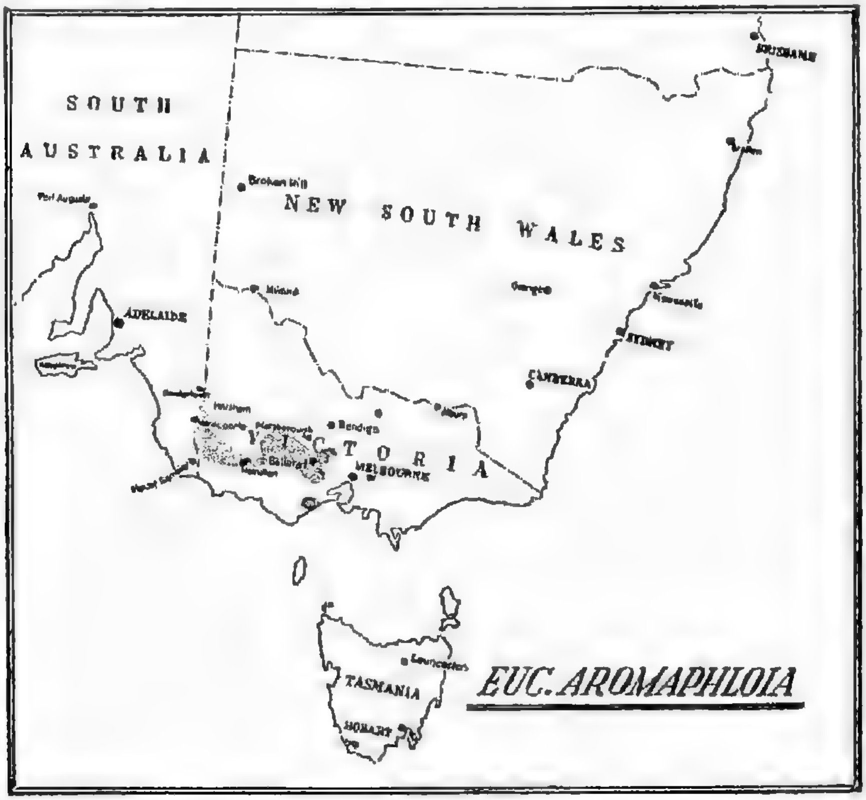

Fig. 2
The present distribution of *E. aromaphloia.*

EUCALYPTUS AROMAPHLOIA

In the area shown on fig. 2, a population distinct from other species occurs quite extensively and has been described in various ways; either as *E. Huberiana,* "Creswick Apple Box" or "Rough-barked Maculosa." If it is proposed that a species belonging to the Macrantherae-Normales having an inflorescence of seven flowers, somewhat furrowed and highly aromatic bark rough to the secondary branches, and juvenile leaves sub-opposite to alternate after about the tenth pair and contracted to a short or very short petiole but not at all stem-clasping, then a relatively uniform population of trees is found to occur in certain situations within the area shown in fig. 2. Progenies raised from trees possessing these characters and from within this area show relatively small variation in the juvenile foliage when raised from seed. There is a progressive change in juvenile leaf shape and glaucousness from east to west in a clinal sequence (which is characteristic of many species), although from a single locality within this zone they are as uniform as is customary in *Eucalyptus.* On the other hand, if at junctions between the population area of this tree and species such as *E. ovata,*

E. elaeophora and *E. viminalis*, individuals are selected which appear to be hybrid between it and the second species, the progeny raised from such individuals discloses segregation comparable with that obtained from similar suspected hybrids in many other cases.

There are good grounds, therefore, for erecting *E. aromaphloia* as a species. It conforms with three requirements which apply well in judging whether a proposed type fairly represents a species of Eucalyptus. These are:—

(1) A species must be a population.
(2) It must be morphologically distinct.
(3) It should be reproductively isolated.

The isolation in Eucalyptus is very commonly ecological in that interbreeding species occupy different ecological situations. In the case of *E. aromaphloia*, the most common species occurring at habitat junctions with it in the field with which it can be interbred are *E. ovata*, which occupies more swampy sites; *E. elaeophora*, which occupies generally harder, drier, more "ridgy" sites; *E. viminalis*, which occupies generally damper or somewhat cooler sites. The information obtained from progeny tests of these combinations is presented by the histograms in fig. 3, a, b and c. On the basis of its characters there is some difficulty in placing it in one of the established series. The treatment by Blakely (as he admits) is inadequate particularly with regard to the series Microcarpae. Blakely says, "This series may appear to be more artificial than natural, and its members cannot very well be merged into any of the other series." If, however, a series is erected to embrace Blakely's sub-series Semi-Decorticatae, and there removing *E. ovata*, *E. camphora* and *E. aggregata* from the series Sub-Exsertae, these species are then conveniently placed with *E. maculosa*, *E. acaciaeformis*, *E. Nicholi*, *E. scoparia* and *E. aromaphloia*, in a series which is characterised within the Macrantherae (Normales) by juvenile leaves sub-opposite or alternate after a few pairs, and which are from very shortly petiolate to petiolate.

A considerably more satisfactory explanation and treatment of the "*Huberiana*" eucalypt population of the south-east of South Australia and the Mount Lofty Ranges is thus achieved. *E. aromaphloia* appears to reach the present limit of its range in the south-east of South Australia, and individuals corresponding fairly well with the general population of the species occur commonly enough, but there is generally what appears to be an extensive swarm between it and *E. viminalis* through much of the area. In the Mount Lofty Ranges and Kangaroo Island the swarm exists, but there are apparently no stands of *E. aromaphloia* extant. For further explanation of the position it is necessary to speculate on the possible population movements in the light of evolutionary genetic theory in relation to sub-recent climatic changes.

E. VIMINALIS AND E. AROMAPHLOIA IN RELATION TO SUB-RECENT CLIMATIC CHANGES

The pattern of distribution of *E. viminalis* and the associated hybrid swarms fits well with the kind of climatic change described by Crocker and Wood (1947). There is a growing body of evidence that Australia endured a dry period perhaps only 5,000 years ago and that before this period conditions were considerably more equable. An arid period as recently as this date would, of course, have appeared on a landform unaltered appreciably from the present. It is uncertain, as Downes (1954) says, to what extent the present-day climate has emerged from that of the arid period, but there seems to be some vegetational evidence for a slight spread of species outwards from a still more narrow limit than the present-day distribution. If this pattern of climatic change is correct, the present-day pattern of distribution of *E. viminalis* and *E. aromaphloia* and its segregating swarm fits in well with the pattern of climatic change.

E. viminalis reaches its best development in cool situations in areas with rainfall of 35 inches per annum or more. It occurs up to 4,500 ft. elevation in the vicinity of Mount Kosciusko. A relatively cool and moist period, therefore, which presumably preceded the arid period, would favour the occupation of a much wider area by *E. viminalis* than at present. There are many present-day examples of *E. viminalis* growing on sandy soils comparable with those extending from the south-east of South Australia to the Mount Lofty Ranges, and a relatively moderate variation in climate giving a rainfall no more than 50% above the present figures would almost certainly permit the continuous distribution of *E. viminalis* from the Mount Lofty Ranges to the Grampians in Victoria and then continuously to its present range. Likewise, *E. aromaphloia*, while thriving in conditions not quite as moist as those normally occupied by *E. viminalis*, also obviously is favoured by relatively cool and moist conditions and would therefore also be expected to have a much more extensive range. In such circumstances it is easy to imagine *E. viminalis* and *E. aromaphloia*, along with several other species such as *E. ovata* and *E. rubida*, occupying their appropriate ecological niches continuously over the area between the Grampians and the Mount Lofty Ranges.

A hardening of the climate from the condition which permitted such a distribution would cause a contraction of species like *E. viminalis* and *E. aromaphloia* towards any available "refuge," as suggested by Crocker and Wood. Such movements have undoubtedly occurred in the past and must certainly have been associated with changes in genetic balance. On some occasions it seems clear that hybrid swarms between two previously established species were able to thrive in the marginal areas better than either parent. Where extensive hybrid swarms have developed, as apparently is the case between *E. viminalis* and *E. aromaphloia*, there is still a good deal of diversity in the population and it may well be that the number of generations which have elapsed since the onset of the arid period is as few as twenty-five. Greater genetic uniformity, therefore, could scarcely be expected and it may well be that the occurrence of scattered hybrid "phantoms" in stands in areas from which now one of the putative parents is missing and in other cases of extensive hybrid swarms is a reflection of the fact that marked movements, especially in some areas of the continent, have been imposed on the *Eucalyptus* populations as the result of a quite recent arid period on the present land form. It has been suggested by Stebbins (1950) that this kind of change provides one of the means by which new species evolve, and it seems that the extensive segregating swarms of *E. viminalis* and *E. aromaphloia* in Victoria and South Australia may yet proceed to greater genetic stability and give a good example of this kind of speciation.

A similar situation exists with *E. viminalis* in other parts of its range, particularly the New England Tableland and the upper altitudinal limits of its range in central Victoria and the adjoining areas of New South Wales and similarly in central Tasmania. In these cases, however, the combining species are not *E. aromaphloia* and thus the pattern differs to this extent, although the general situation is similar.

CONCLUSIONS

It is considered that a more satisfactory explanation than that employed hitherto for the "*Huberiana*" populations of South Australia and Victoria is found by adopting the following views:—

(1) *E. Huberiana* should be discarded as a *nomen ambiguum*.

(2) *E. aromaphloia* should be erected and reckoned to have a distribution from central to south-western Victoria and to the south-east of South Australia.

(3) Most of the material in South Australia and Victoria generally referred to *E. viminalis* var. *Huberiana* Burbidge, or *E. Huberiana* Naudin, should be considered a segregating hybrid swarm of *E. viminalis* x *E. aromaphloia*.

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THE POINT MARSDEN CAMBRIAN BEDS, KANGAROO ISLAND, SOUTH AUSTRALIA

BY R. C. SPRIGG

Summary

Index fossils *(Redlichia* and *Lusatiops)* have now been found in the Point Marsden beds of Kangaroo Island. They are thought to indicate an uppermost Lower Pre-Cambrian age. These fossils occur in the Emu Bay Shales associated with a succession of slump-bedded sandstones (the Stokes Bay Sandstone) considered to be near the edge of the ancient Cambrian Continental terrace in this region. Ubiquitous internal convolutions within individual sandstone lenses evidence widespread instability with gliding to the south, possibly down a "continental" type slope. The *White Point Limestone* also within the succession is a conglomeratic development of the nature of an outer slope breccia to a reef-like bioherm. Its fragments are extensively squeezed, evidencing lack of consolidation at time of formation, and a few of them contain Archaeocyathina.

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By R. C. Sprigg

[Read 11 November 1954]

SUMMARY

Index fossils (*Redlichia* and *Lusatiops*) have now been found in the Point Marsden beds of Kangaroo Island. They are thought to indicate an uppermost Lower Pre-Cambrian age. These fossils occur in the Emu Bay Shales associated with a succession of slump-bedded sandstones (the Stokes Bay Sandstone) considered to be near the edge of the ancient Cambrian Continental terrace in this region. Ubiquitous internal convolutions within individual sandstone lenses evidence widespread instability with gliding to the south, possibly down a "continental" type slope. The *White Point Limestone* also within the succession is a conglomeratic development of the nature of an outer slope breccia to a reef-like bioherm. Its fragments are extensively squeezed, evidencing lack of consolidation at time of formation, and a few of them contain Archaeocyathina.

In 1928 the late Dr. C. T. Madigan described in detail a group of beds occurring along the north-east coast of Kangaroo Island, north of Kingscote, in which boulders carrying *Archaeocyatha* occurred plentifully. The beds had previously been recorded by Howchin (1899) and Wade (1915). They were variously ascribed to the Cambrian System or later in the Palaeozoic Era. They were described as lying unconformably on the metamorphic core complex of the Island (Kanmantoo Group), which in turn was considered to be Precambrian Age. The Kanmantoo Group is now known to range from the Cambrian to perhaps Ordovician Period. (Sprigg and Campana, 1953.)

Dr. Madigan designated these younger sediments the Point Marsden Beds and considered them to be possibly Post-Cambrian in age. He found raindrop impressions in some of the more slaty horizons, and observed obscure animal tracks, presumed to be those of trilobites. Dr. Madigan returned to the Island in 1945 with a party of students intending to search more diligently for fossils in original situation, but unfortunately developed sickness which was eventually to lead to his untimely death. The expedition was interrupted and little of significance was accomplished, except that a party of students (personal communication by Mr. R. Ayliffe) reported evidence of basal unconformity with the then presumed Precambrian to the west of Stokes Bay.

In 1952, while preparing the four-mile map sheet of Kingscote (published 1954), the writer made several discoveries of considerable significance concerning these beds, including the discovery of marker fossils, and much new evidence concerning the nature and field relations of the sediments as a whole.

DEFINITION AND REGIONAL EXTENT OF THE POINT MARSDEN GROUP

This succession of conglomerates, sandstones, slates and limestones outcrops intermittently along the north coast of Kangaroo Island from Point Marsden, westward probably to Snelling Beach, a distance of about forty miles. Landward it extends south to the base of the Cygnet and Snelling fault escarpments (Sprigg, 1954). The beds are dominantly subhorizontal except in the approaches to each of a set of imbricate (reversed) faults trending east-west to E.S.E. - W.N.W. which hade to the south at about 45 degrees. The beds are Cambrian in age and preserve conformable relationships with underlying phyllites presumed to be uppermost members of the reduced Adelaide System in this area. They abut the Kanmantoo Group along the foregoing fault escarpment, and themselves are cut by deep valleys of Permian age, choked with glacial debris.

THE SEDIMENTARY SUCCESSION

Phyllites of the Adelaide System are overlain conformably by a massive, medium-grained sandstone development, herein named the *Stokes Bay Sandstone*. The formation is possibly 1,000 feet thick but cannot be observed completely because of faulting; it may thicken to the west. It is reddish or whitish in colour and is characterized by marked internal slumping and normal and pseudo-crossbedding (see later). The sandstone is succeeded by grey shales (*Emu Bay Shales*, 300-400 feet thick) with interbedded quartzites, the former of which carry a newly-discovered trilobite fauna. After a break in the succession due to the interposition of Emu Bay, the succession (still dipping easterly) *apparently* continues with purple shales followed by at least 200 feet of the boulder-breccia limestone which will be called the *White Point Limestone*. These are overlain by more slate and boulder beds followed in the extreme east by numerous conglomerate bands, set in cross-bedded sandstone. Unfortunately, due to an accident which befell the writer, this succession was not mapped nor measured in detail. Further field work is required to check for internal faulting which may effect the order of the beds and thicknesses.

The White Point Limestone consists of closely packed, coarse fragments of whitish and yellowish dolomite and limestone, some of which contain *Archaeocyatha*. The boulders frequently attain two feet or more in length and there is little interstitial material. There is little or no evidence of sorting, or of obvious abrasion rounding of fragments throughout the whole mass of the deposit. Frequently the limestone fragments are squeezed in a manner suggestive of compaction following burial, in which case the "boulders" could have been only partially consolidated at that time. Extraneous matter in the limestone breccias consists of not infrequent, small, well-rounded pebbles of unusually red gneissic granite and black schists not found elsewhere on Kangaroo Island, except in the overlying pebble conglomerates of Point Marsden.

THE NATURE OF THE SEDIMENTARY ENVIRONMENT

It has been inferred elsewhere (Sprigg 1952) that Kangaroo Island lay near the platform edge of the ancient Proterozoic-Cambrian continental terrace which constituted the Adelaide (Mio) geosyncline in South Australia. The continental platform locally was a more stable zone extending landwards (north and west) onto neighbouring shelf and shield areas. Beyond the shelf edge, the continental slope environment possibly extended to ocean depths in a south-easterly direction, with steep unstable sediment slopes, which in Cambrian time possibly simulated conditions now existing beyond the south-eastern extremity of the modern Australian Continent. The Point Marsden beds were apparently accumulated near the outer edge of a narrowing continental platform (Platform-edge environment).

There is also reason to believe that positive and negative land movements were in progress at the time. These would have enhanced the tendency to rapidly transport sediments across the platform-edge, and would also have permitted raindrop impressions to be recorded in exposed arid, red bed sediments (now shales), and also the growth, nearby to the north, of shelf-edge bioherms (Archaeocyatha reefs). The climate at this time appears to have been warm, possibly arid, following late Proterozoic glaciation.

Of special interest concerning the nature of this environment are the massive slump structures of the Stokes Bay Sandstone, the presumed contemporaneous Kanmantoo developments to the south, and also the remarkable sedimentary breccia—conglomerate constituting the *White Point Limestone*.

The Stokes Bay Sandstone is remarkable for the magnitude and number of slump structures contained within its mass. Subaqueous sliding and gliding phenomena are almost ubiquitous within the formation, but mostly the structures

are coarse, and evidencing much apparent erosion truncation, which in turn suggests a shallow water environment. One tongue of sandstone, for example, may be flat-bedded but on either "facing" the sediment may be highly contorted and attenuated, in a manner which can only suggest gravity slumping of water-soaked sediment. The undersurfaces of many of the layers are grooved and rounded in the direction of presumed movement, whereas the upper surfaces are truncated and on occasions may be ripple marked.

By way of comparison, the more quartzitic members and those within the Kanmantoo Succession to the south are thinner and display far more attenuated slumps and "glide-rolling." By the latter is meant the tendency for folds to develop within a particular slumped bed, and to curl over in the direction of gravitational movement; these become extremely attenuated to finish as "extruded" recumbent folds strongly recalling alpine fold nappes on vastly reduced scales. Study of these remarkable features (which have since been found to be well developed in the Ordovician Sandstones of the Indulkana Range, in north-western South Australia) may provide important leads to Alpine "tectonics."

In the Kanmantoo beds these slump structures are almost always eroded on the surface by subsequent slumped sediments, but the surfaces, unlike those of gliding formations within the Stokes Bay Sandstone, are parallel with the base and do not show the same tendency to inter-surface irregularity. This is thought to argue a deeper water environment and steeper slopes for the former, a supposition supported by the poorer sorting and Flysch-like character of the Kanmantoo Succession generally (Sprigg and Campana, 1953).

In this way it is deduced that the Stokes Bay Sandstone is a terrace platform edge development, adjacent to a steep continental slope. Its sands are well sorted, but the element of instability consequent upon a platform-edge location, and accentuated perhaps also by regional uplift and consequent coastal migration to seawards, is always present.

In this light, the origin of the *White Point Limestone* breccias may now be contemplated a little more clearly. As described previously, these sediments contain plentiful *Archaeocyatha* as remanié boulders which, by their coarseness, and the absence of obvious abrasion rounding could not have travelled far. Also, the boulders appear to have been unconsolidated at the time of deposition, being subsequently squeezed by vertical loading pressures; the environment of the outer reef talus slope is suggested. This is in keeping with the probable habitat of *Archoeocyatha* which are considered to have lived in bioherms simulating modern barrier reefs and their associated coral meadows. Their preference for warm seas, on an east-facing continental coast, further enhanches the analogy which however should not be taken too far for these problematic sponge-like creatures are only occasionally found in densely massed colonies. Another complication concerns the occurrence of numerous well-rounded pebbles of red granite and black schist which the writer knows only from northern Yorke Peninsula (*e.g.*, Point Pearce, Pine Point, etc.). In a theory involving "barrier" type reefs, these could only enter such an environment of restricted clastic sedimentation *via* floating sea weeds with holdfasts. The writer can see no obvious alternative explanation, as these granite and schist fragments are well rounded. If, however, some local fault escarpment with breccia and talus developments is inferred, hard rock fragments would be far less abraded than the soft tumbled limestone fragments, which is not the case.

In consideration of the fossil fauna, other than the *Archaeocyatha*, the Point Marsden environment was obviously not always one of active coarse clastic sedimentation. The occurrence of abundant trilobites and brachiopods suggests a relatively shallow water environment with a muddy bottom, interrupted only by local sand banks.

THE FOSSIL FAUNA

At least two richly fossiliferous but narrow zones occur in slates about 200 yards north-west of the Emu Bay Jetty. The horizons occur about 100 feet above the *Stokes Bay Sandstone* and below the *White Point Limestone*. Dr. M. F. Glaessner, who has examined the fauna and who will describe it elsewhere, records the following species:

Redlichia n. sp., *Lusatiops* n. sp., *Acrothele* sp., *Hyolithes* sp.

Dr. Glaessner observes that the Family Protolenidae in general, and *Lusatiops* in particular, are considered as restricted to the Lower Cambrian where they characterise one of the youngest zones. *Redlichia* is reported as ranging from Lower to Middle Cambrian. The two genera do not appear to have been found previously associated in the same beds. On this basis the fossiliferous beds of Kangaroo Island are provisionally placed in the uppermost Lower Cambrian.

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ABSTRACT OF EXHIBITS SHOWN AT THE ORDINARY MEETING ON 10 NOVEMBER 1954

Summary

ABSTRACT OF EXHIBITS SHOWN AT THE ORDINARY MEETING ON 10 NOVEMBER 1954

THE EFFECT OF COLD SHOCK IN PRODUCING ARTIFICIAL TERATOLOGICAL DEFORMITIES IN ERYTHRAEID MITES

The President, Dr. R. V. Southcott, presented normal and teratological specimens of the larva of the Erythraeid mite *Erythraeus reginae* (Hirst). The living larvae shown had been reared from eggs collected in the Adelaide region, from splits in the tops of fencing posts, under or near *Eucalyptus camaldulensis,* and close to water courses. The eggs had been laid in the preceding summer. In southern Australia these eggs hatch between September and December. Batches of eggs were chilled experimentally to varying temperatures and for varying periods. In one batch, cooled to $-3°$ F. for one hour on 27 June 1954, larvae with gross teratological abnormalities of the dorsal scutum hatched in November. In these the scutal non-sensillary setae were reduced in number or absent. Below the scutum and elsewhere were chitinous knots which in some cases resembled expanded setae.

These experiments had been suggested by the finding of abnormal larvae of *Erythraeus reginae* and *E. urrbrae* at Inman Valley, South Australia, in December 1952, the major abnormalities being gross "clubfoot," and in the palp. The winter of 1952 had had an abnormally high number of frosts. The deformities seen experimentally differed from those observed in nature. Whether this was due to differences in the stimuli was uncertain. Nevertheless, it may be concluded that cold shock to the deutovum stage causes teratological deformities in the larva, of a kind not seen identically in nature, the differences being normally significant at the generic level of classification. Further observations were being made.

Precambrian Problematica

Dr. Southcott exhibited also specimens of the ochraceous problematica named *Beaumontia eckersleyi* by David and Tillyard, collected in 1939 at Beaumont Quarries, Glen Osmond, South Australia. Reference was made to the recent re-working of the quarry. The specimens shown had a uniformity of structure which indicated an organic origin.

BALANCE SHEET

Summary

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED)

Receipts and Payments for the Year ended 30th September, 1954

	£	s.	d.	£	s.	d.
To Balance, 1/10/53				1,212	1	8
„ Subscriptions				531	17	0
„ Government Grant for Printing, etc.:—						
1953/4 (balance)	1,150	0	0			
1954/5 (1st instlt.)	375	0	0	1,525	0	0
„ Sale of Publications and Reprints				147	1	6
„ Interest				232	11	9
„ Hire of Hall				4	4	0
				£3,652	15	11

By Transactions—	£	s.	d.	£	s.	d.
Printing and Publishing						
Vol. 76 (part)	344	8	8			
Vol. 77	1,147	17	6	1,492	6	2
„ Reprints				34	16	0
„ Library Assistants				171	5	11
„ „ (Female)				132	15	0
„ Printing and Stationery				51	9	9
„ Postages, Duty Stamps, etc.				62	18	4
„ Postages on Transactions				75	3	9
„ Book-binding				438	2	6
„ New Shelving				292	4	6
„ Cabinet				65	6	1
„ Typewriter and Chairs				89	7	6
„ Addressing Machine				55	14	0
„ Cleaning				47	12	0
„ Insurance				8	2	6
„ Lighting				24	16	0
„ Centenary Celebrations				33	5	0
„ Sundries				22	12	1
„ Balance— Savings Bank of S.A.:						
General A/c. 549 0 9						
Ex Endowment Fund 13 4 9						
Rundle St. A/c. 11 9 3						
573 14 9						
Less Outstanding Chqus 3 7 3						
0 10 0						
36 2 3						
2 17 0 — 42 16 6	530	18	3			
Cash on hand	24	0	7	554	18	10
				£3,652	15	11

ENDOWMENT FUND

Receipts and Payments for the Year ended 30th September, 1954

	£	s.	d.	£	s.	d.
1953—October 1						
To Balance—						
Commonwealth Inscribed Stock	6,010	0	0			
Savings Bank of S.A. ..	62	18	7	6,072	18	7
1954—Sept. 30						
To Interest—						
Inscribed Stock	199	14	6			
Savings Bank of S.A.	32	17	3	232	11	9
				£6,305	10	4

	£	s.	d.	£	s.	d.
1954—Sept. 30						
By Revenue A/c.				232	11	9
„ Balance—						
Commonwealth Inscribed Stock	6,010	0	0			
Savings Bank of S.A.	62	18	7	6,072	18	7
				£6,305	10	4

Audited and found correct. The Stock and Bank Balances have been verified by certificates from the respective institutions.

F. M. ANGEL
N. ANGEL, A.U.A. Com. } Hon. Auditors

H. M. HALE, Hon. Treasurer

Adelaide, 12 October 1954

AWARDS OF THE SIR JOSEPH VERCO MEDAL AND LIST OF FELLOWS, MEMBERS, ETC.

Summary

AWARDS OF THE SIR JOSEPH VERCO MEDAL

1929 Prof. Walter Howchin, F.G.S.
1930 John McC. Black, A.L.S.
1931 Prof. Sir Douglas Mawson, O.B.E., D.Sc., B.E., F.R.S.
1933 Prof. J. Burton Cleland, M.D.
1935 Prof. T. Harvey Johnston, M.A., D.Sc.
1938 Prof. J. A. Prescott, D.Sc., F.A.I.C.
1943 Herbert Womersley, A.L.S., F.R.E.S.
1944 Prof. J. G. Wood, D.Sc., Ph.D.
1945 Cecil T. Madigan, M.A., B.E., D.Sc., F.G.S.
1946 Herbert M. Hale

LIST OF FELLOWS, MEMBERS, ETC.

AS AT 30 JUNE 1955

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.

Any change in address or any other changes should be notified to the Secretary.

Note—The publications of the Society are not sent to those members whose subscriptions are in arrear.

Date of Election.

Honorary Fellows

1949. *Cleland, Prof. J. B., M.D., Dashwood Road, Beaumont, S.A.—*Fellow*, 1895-1949; *Verco Medal*, 1933; *Council*, 1921-26, 1932-37; *President*, 1927-28; 1940-41; *Vice-President*, 1926-27, 1941-42.

1955. *Mawson, Prof. Sir Douglas, O.B.E., D.Sc., B.E., F.R.S., University of Adelaide—*Verco Medal*, 1931; *President*, 1924-25, 1944-45; *Vice-President*, 1923-24, 1925-26; *Council*, 1941-43.

1955. *Osborn, Prof. T. G. B., D.Sc., 6 Magdalen Street, College Park, S.A.—*Council*, 1915-20, 1922-24; *President*, 1925-26; *Vice-President*, 1924-25, 1926-27.

1955. *Ward, L. K., I.S.O., B.A., B.E., D.Sc., 22 Northumberland Street, Heathpool, Marryatville, S.A.—*Council*, 1924-27, 1933-35; *Vice-President*, 1927-28; *President*, 1928-30.

Fellows.

1946. Abbie, Prof. A. A., M.D., D.Sc., Ph.D., University of Adelaide.

1953. Adcock, Miss A., 4 Gertrude Street, Norwood, S.A.

1951. Aitchison, G. D., B.E., Civil Engineering Department, University of Melbourne, Carlton, Victoria.

1927. *Alderman, Prof. A. R., Ph.D., D.Sc., F.G.S., University of Adelaide—*Council*, 1937-42, 1955.

1951. Anderson, Mrs. S. H., B.Sc., Zoology Dept., University of Adelaide, S.A.

1951. Andrews, J., M.B., B.S., 40 Seafield Avenue, Kingswood, S.A.

1935. *Andrewartha, H. G., M.Agr.Sc., D.Sc., Zoology Department, University of Adelaide—*Council*, 1950; *Vice-President*, 1950-51; *President*, 1951-.

1935. *Andrewartha, Mrs. H. V., B.Agr.Sc., M.S., (nee H. V. Steele), 29 Claremont Avenue, Netherby, S.A.

1929. *Angel, F. M., 34 Fullarton Road, Parkside, S.A.

1939. *Angel, Miss L. M., M.Sc., c/o Mrs. C. Angel, 2 Moore Street, Toorak, Adelaide, S.A.

1945. *Bartlett, H. K., L.Th., 2 Abbotshall Road, Lower Mitcham, S.A.

1950. Beasley, A. K., Harris Street, Marden, S.A.

1950. Beck, R. G., B.Ag.Sc., R.D.A., Lynewood Park, Mil-Lel, via Mount Gambier, S.A.

1932. Begg, P. R., D.D.Sc., L.D.S., Shell House, 170 North Terrace, Adelaide.

1928. Best, R. J., D.Sc., F.A.C.I., Waite Institute (Private Mail Bag), Adelaide.

1934. Black, E. C., M.B., B.S., Magill Road, Tranmere, Adelaide.

1950. Bonnin, N. J., M.B., B.S., F.R.C.S. (Eng), F.R.A.C.S., 40 Barnard Street, North Adelaide, S.A.

1945. *Bonython, C. W., B.Sc., A.A.C.I., Romalo House, Romalo Avenue, Magill, S.A.

1940. Bonython, Sir J. Lavington, 263 East Terrace, Adelaide.

1945. *Boomsma, C. D., M.Sc., B.Sc.For., 6 Celtic Avenue, South Road Park, S.A.

1947. *Bowes, D. R., Ph.D., M.Sc., D.I.C., F.G.S., Geology Department, University College, Swansea, Wales.

1939. Brookman, Mrs. R. D. (nee A. Harvey), B.A., Meadows, S.A.

1944. *Burbidge, Miss N. T., M.Sc., C.S.I.R.O., Div. Plant Industry, P.O. Box 109, Canberra, A.C.T.

1923. Burdon, R. S., D.Sc., University of Adelaide—*Council*, 1946.

Date of Election.

1922. *CAMPBELL, PROF. T. D., D.D.Sc., D.Sc., Dental Dept., Adelaide Hospital, Adelaide—*Council*, 1928-32, 1935, 1942-45; *Vice-President*, 1932-34; *President*, 1934-35.
1953. CARTER, A. N., B.Sc., 70 Madeline Street, Burwood E 13, Vict.
1951. CHITTLEBOROUGH, R. G., B.Sc., c/o C.S.I.R.O., Div. of Fisheries, 1 Museum Street, Perth, W.A.
1929. CHRISTIE, W., M.B., B.S., 7 Walter Street, Hyde Park, Adelaide, S.A.—*Treasurer*, 1933-38.
1955. CLOTHIER, E. A., c/o Department of Mines, Adelaide, S.A.
1949. COLLIVER, F. S., Geology Department, University of Queensland.
1907. *COOKE, W. T., D.Sc., A.A.C.I., 4 South Terrace, Kensington Gardens, S.A.—*Council*, 1938-41; *Vice-President*, 1941-42, 1943-44; *President*, 1942-43.
1929. *COTTON, B. C., S.A. Museum, Adelaide—*Council*, 1943-46, 1948-49; *Vice-President*, 1949-50, 1951; *President*, 1950-51.
1953. DANE, D. M. S., M.B., B.Chir., M.R.C.S., L.R.C.P., B.A., Institute of Medical and Veterinary Science, Frome Road, Adelaide.
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1930. DIX, E. V., Hospitals Department, Rundle Street, Adelaide, S.A.
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1931. DWYER, J. M., M.B., B.S., 105 Port Road, Hindmarsh, S.A.
1933. *EARDLEY, MISS C. M., M.Sc., University of Adelaide—*Council*, 1943-46.
1945. *EDMONDS, S. J., B.A., M.Sc., Zoology Department, University of Adelaide.
1902. *EDQUIST, A. G. 19 Farrell Street, Glenelg, S.A.—*Council*, 1949-1953.
1927. *FINLAYSON, H. H., 305 Ward Street, North Adelaide—*Council*, 1937-40.
1951. FISHER, R. H., 265 Goodwood Road, Kings Park, S.A.
1923. *FRY, H. K., D.S.O., M.D., B.S., B.Sc., F.R.A.C.P., Town Hall, Adelaide—*Council*, 1933-37; *Vice-President*, 1937-38, 1939-40; *President*, 1938-39.
1951. FULTON, COL. D., C.M.G., C.B.E., Aldgate, S.A.
1955. GILES, E. T. (Dr.), c/o S.A. Museum, North Terrace, Adelaide, S.A.
1954. GIBSON, A. A., A.W.A.S.M., Geologist, Mines Department, Adelaide.
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1927. GODFREY, F. K., Box 951H, G.P.O., Adelaide.
1935. †GOLDSACK, H., Coromandel Valley, S.A.
1910. *GRANT, PROF. SIR KERR, M.Sc., F.I.P. 56 Fourth Avenue, St. Peters, S.A.
1951. GREEN, J. W., 6 Bedford Avenue, Subiaco, West Australia.
1904. GRIFFITH, H. D., 13 Dunrobin Road, Brighton, S.A.
1948. GROSS, G. F., B.Sc., South Australian Museum, Adelaide—*Secretary*, 1950-.
1944. GUPPY, D. J., B.Sc., c/o W.A. Petroleum Co., 251 Adelaide Terrace, Perth, W.A.
1922. *HALE, H. M., Director S.A. Museum, Adelaide—*Verco Medal*, 1946; *Council*, 1931-34, 1950-; *Vice-President*, 1934-36, 1937-38; *President*, 1936-37; *Treasurer*, 1938-1950.
1949. HALL, D. R., Tea Tree Gully, S.A.
1930. HANCOCK, N. L., 3 Bewdley, 66 Beresford Road, Rose Bay, N.S.W.
1953. *HANSEN, I. V., B.A., 34 Herbert Road, West Croydon, S.A.
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1951. HOCKING, L. J., School House, Renmark West, S.A.
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1917. HUTTON, J. T., B.Sc., 18 Emily Avenue, Clapham.
1928. IFOULD, P., 14 Wyatt Road, Burnside, S.A.
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1939. †KHAKHAR, H. M., Ph.D., M.B., F.R.G.S., Khakhar Buildings, C.P. Tank Road, Bombay, India.
1949. *KING, D., M.Sc., c/o Department of Mines, Flinders Street, Adelaide.
1933. *KLEEMAN, A. W., M.Sc., Ph.D., University of Adelaide—*Secretary*, 1945-58; *Vice-President*, 1948-49, 1950-51; *President*, 1949-50.
1951. KOLAROVIC, D., B.A.Sc. (Mun.), 65 David Terrace, Kilkenny, S.A.

Date of Election.

1922. LENDON, G. A., M.D., B.S., F.R.C.P., A.M.P. Building, King William Street, Adelaide,
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1931. *LUDBROOK, MRS. N. H., M.A., Ph.D. D.I.C., F.G.S., Department of Mines, 31 Flinders Street, Adelaide.
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1953. MAELZER, D. A., B.Sc. (Hons.), Waite Institute, Adelaide.
1932. MANN, E. A., C/o Bank of Adelaide, Adelaide.
1939. MARSHALL, T. J., M.Agr.Sc., Ph.D., Waite Institute (Private Mail Bag), Adelaide—*Council*, 1948-.
1920. MAYO, THE HON. MR. JUSTICE, LL.B., K.C., 19 Marlborough Street, College Park,
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1925. †MITCHELL, PROF. SIR W., K.C.M.G., M.A., D.Sc., Fitzroy Ter., Prospect, SA.
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1951. MITCHELL, F. J., c/o The South Australian Museum, North Terrace, Adelaide.
1938. MOORHOUSE, F. W., M.Sc., Chief Inspector of Fisheries, Simpson Buildings, Gawler Place, Adelaide.
1936. *MOUNTFORD, C. P., 25 First Avenue, St. Peters, Adelaide.
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1930. OCKENDEN, G. P., B.A., School House, Box 63, Kimba, S.A.
1947. *OPHEL, I. L., Atomic Energy of Canada, Chalk River, Ontario, Canada.
1937. *PARKIN, L. W., M.Sc., c/o Mines Department, Adelaide—*Secretary*, 1953.
1949. PARKINSON, K. J., B.Sc., Whitwarta Road, Balaklava, S.A.
1929. PAULL, A. G., M.A., B.Sc., 10 Milton Avenue, Fullarton Estate, S.A.
1926. *PIPER, C. S., D.Sc., Waite Institute (Private Mail Bag), Adelaide—*Council*, 1941-43; *Vice-President*, 1943-45, 1946-47; *President*, 1945-46.
1948. POWRIE, J. K., B.Sc., C.S.I.R.O., Keith, S.A.
1949. PRAITE, R. G., 81 Park Terrace, North Unley, S.A.
1925. *PRESCOTT, PROF. J. A., C.B.E., D.Sc., A.I.C., F.R.S., Waite Institute (Private Mail Bag), Adelaide—*Verco Medal*, 1938; *Council*, 1927-30, 1935-39; *Vice-President*, 1930-32; *President*, 1932-33.
1945. PRYOR, L. D., M.Sc., Dip. For., Dept. of Interior, Canberra, A.C.T.
1950. *RATTIGAN, J. H., M.Sc., c/o Rio Tinto Ltd., Darwin, Northern Territory.
1951. RAYSON, P., B.Sc., c/o Botany Department, University of Adelaide.
1944. RICEMAN, D. S., M.Sc., B.Agr.Sc., C.S.I.R.O., Division of Nutrition, Adelaide.
1947. RIEDEL, W. R., B.Sc., S.A. Museum, Adelaide.
1948. *RIMES, G. D., B.Sc., c/o Muresk Agricultural College, Muresk, W.A.
1947. RIX, C. E., 42 Waymouth Avenue, Glandore, S.A.
1953. ROGERS, PROF. S. W. P., Ph.D., Zoology Department, University of Adelaide.
1951. ROWE, S. A., 22 Shelley Street, Firle, S.A.
1951. ROWE, S. F., B.Sc., Gordon Institute of Technology, Geelong, Victoria.
1950. RUDD, PROF. E. A., B.Sc., A.M., University of Adelaide, S.A.
1951. RUSSELL, L. D., c/o High School, Port Pirie, S.A.
1945. RYMILL, J. R., Old Penola Estate, Penola, S.A.
1933. SCHNEIDER, M., M.B., B.S., 175 North Ter., Adelaide.
1951. SCOTT, T. D., B.Sc., c/o S.A. Museum, North Terrace, Adelaide, S.A.
1946. *SEGNIT, E. R., M.Sc., Ph.D., Geology Department, University of Adelaide.
1924. *SEGNIT, R. W., M.A., B.Sc., Engineering and Water Supply Department, Victoria Square, Adelaide—*Secretary*, 1930-35; *Council*, 1937-38; *Vice-President*, 1938-39, 1940-41; *President*, 1939-40.
1925. *SHEARD, H., Port Elliot, S.A.
1936. *SHEARD, DR. K., M.Sc., Fisheries Research Div. C.S.I.R.O., University of W.A., Nedlands, W.A.

Date of Election

1954. SHEPHERD, R. G., B.Sc., c/o Department of Mines, Adelaide.
1934. SHINKFIELD, R. C., 57 Canterbury Avenue, Trinity Gardens, S.A.
1949. SIMPSON, D. A., M.B., B.S., The Manor House, Great Haseley, Oxfordshire, England.
1925. †SMITH, T. E. BARR., B.A., 25 Currie Street, Adelaide.
1941. *SMITH, T. L., B.Sc., Regional Planning Section. Department of National Development, Canberra, A.C.T.
1941. *SOUTHCOTT, R. V., M.B., B.S., D.T.M. & H., 13 Jasper Street, Hyde Park, S.A.—*Council*, 1948-51; *Treasurer*, 1951-; *President*, 1955-56.
1936. SOUTHWOOD, A. R., M.D., M.S. (Adel.), M.R.C.P., 170 North Terrace, Adelaide.
1947. *SPECHT, R. L., Ph.D., Botany Department, University of Adelaide—*Council*, 1951-.
1936. †*SPRIGG, R. C., M.Sc., 5 Baker Street, Somerton Park.
1951. STEADMAN, REV. W. R., 8 Blairgowrie Road, St. Georges, S.A.
1947. SPURLING, M. B., B.Ag.Sc., Horticultural Branch, Department of Agriculture, Box 901 E, G.P.O., Adelaide.
1949. *SPRY, A. H., M.Sc., Geology Department, University of Tasmania.
1938. *STEPHENS, C. G., D.Sc., Waite Institute (Private Mail Bag), Adelaide.
1955. SWAINE, DR. C. D., Repatriation Sanatorium, Belair, S.A.
1932. SWAN, D. C., M.Sc., Waite Institute (Private Mail Bag). Adelaide—*Secretary*, 1940-42; *Vice-President*, 1946-47, 1948-49; *President*, 1947-48; *Council*,
1948. SWANN, F. J. W., Box 156, P.O. Burnie, Tasmania.
1951. SWIRSKI, P., M.Ag.Sc., 618 Seaview Road, Grange, S.A.
1934. SYMONS, I. G., 35 Murray Street, Lower Mitcham, S.A.—*Editor*, 1947-.
1929. *TAYLOR, J. K., B.A., M.Sc., Waite Institute (Private Mail Bag), Adelaide—*Council*, 1940-43, 1947-50; *Librarian*, 1951-; *President*, 1954-55; *Council*, 1955
1955. THATCHER, D., B.Sc., Department of Mines, Adelaide.
1948. THOMAS, I. M., M.Sc. (Wales), University of Adelaide—*Secretary*, 1948-50; *Council*, 1950-.
1938. *THOMAS, MRS. I. M. (nee P. M. Mawson), M.Sc., 36 King Street, Brighton.
1940. *THOMSON, CAPT., J. M., 135 Military Road, Semaphore South, S.A.
1923. *TINDALE, N. B., B.Sc., South Australian Museum, Adelaide—*Secretary*, 1935-36; *Council*, 1946-47; *Vice-President*, 1947-48; 1949-50; *President*, 1948-49; *Librarian*,
1925. TURNER, D. C., Brookman Buildings, Grenfell Street, Adelaide.
1950. VIETCH, S. T., Box 92, Port Lincoln, S.A.
1953. WATERMAN, R. A., B.A., M.A., Ph.D., North-western University, Evanston, Illinois, U.S.A.
1954. WEBB, B. P., B.Sc., Radium Hill, S.A.
1954. WELLS, C. B., B.Ag.Sc., Broadlees, Waverley Ridge, Crafers, S.A.
1954. WHITE, A. R., c/o Geology Department, King's College, Strand, W.C. 2, London.
1954. WHITELAW, A. J., B.Sc., Box 167, Port Lincoln.
1946. *WHITTLE, A. W. G., M.Sc., Mines Department, Flinders Street, Adelaide.
1950. WILLIAMS, L. D., "Dumosa," Meningie, S.A.
1946. *WILSON, A. F., M.Sc., University of W.A., Nedlands, W.A.
1938. *WILSON, J. O., C.S.I.R.O., Division of Nutrition, Adelaide.
1954. *WOMERSLEY, H., F.R.E.S., A.L.S. (Hon. causa), S.A. Museum, Adelaide, *Verco Medal*, 1943; *Secretary*, 1936-37; *Editor*, 1937-43, 1945-47; *President*, 1943-44; *Vice-President*, 1944-45; *Rep. Fauna and Flora Protection Committee*, 1945; *Treasurer*, 1950-51.
1954. *WOMERSLEY, H. B. S., Ph.D., University of Adelaide.
1944. WOMERSLEY, J. S., B.Sc., Lae, New Guinea.
1923. *WOOD, PROF. J. G., D.Sc., Ph.D., University of Adelaide—Verco Medal, 1944 *Council*, 1938-40; *Vice-President*, 1940-41, 1942-43; *Rep. Fauna and Flora Board*, 1940-; *President*, 1941-42; *Council*, 1944-48.
1950. WOODARD, G. D., 1 Brigalow Avenue, Kensington Gardens, S.A.
1953. WOODHOUSE, L. R., 15 Robert Street, North Unley, S.A.
1945. WORTHLEY, B. W., B.A., M.Sc., A. Inst. P., University of Adelaide.
1949. YEATES, J. N., L.S., A.M.I.E., A.M.I.M.E., Richards Buildings, 99 Currie Street, Adelaide, S.A.
1944. ZIMMER, W. J., Dip.For., F.L.S. (Lon.), 7 Rupert Street, Footscray West. W.12, Vict.

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